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RI/FS Plan
Project No. 60776

Volume 1 of 3
Quality Assurance Project Plan
Work Plan (Appendix A)
Field Sampling Plan (Appendix B)
Health and Safety Plan (Appendix C)

Prepared for:

Woodstock Municipal Landfill
PRP Group
Woodstock, Illinois

Prepared by:

Warzyn Engineering Inc.
Chicago, Illinois

April 1990

**QUALITY ASSURANCE PROJECT PLAN (QAPP)
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WOODSTOCK MUNICIPAL LANDFILL
WOODSTOCK, ILLINOIS
(June 8, 1990)**

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INTRODUCTION

The United States Environmental Protection Agency requires that PRP-lead investigations under CERCLA have an approved Quality Assurance Project Plan (QAPP) covering environmental measurements. It is the responsibility of the Respondents or their representatives to implement minimum procedures so the accuracy, precision, completeness and representativeness of data collected are known and documented.

This QAPP presents the organization, objectives, functional activities and specific quality assurance (QA) and quality control (QC) activities associated with the Remedial Investigation/Feasibility Study (RI/FS) at the Woodstock Municipal Landfill site located in Woodstock, Illinois. The objective of the RI is to determine the nature and extent of the contamination at the site in order to support the activities of the FS. The objective of the FS is to develop and evaluate appropriate remedial action alternatives based on the RI data.

This QAPP has been prepared using the following guidance documents:

- U.S. EPA, December 1980, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80.
- U.S. EPA, Region V, June 1989, Final Standard Quality Assurance Project Plan Content Document (aka Q.DOCC).
- U.S. EPA, Region V, Content Requirements for Quality Assurance Project Plan prepared by Cheng-Wen Tsai, QAS, Revised January, 1989.

The planning documents for the RI/FS at the Woodstock Site consist of a QAPP, a Work Plan (WP), a Field Sampling Plan (FSP), and a site specific Health and Safety Plan (HSP). Each of the plans has a specific purpose, and efforts have been made to avoid duplication of focus in the documents. The purpose of this QAPP is to describe the specific protocols which will be followed for sampling, sample handling and storage, chain of custody, and laboratory (or field) analysis. The purposes of the other documents are as follows:

- The Work Plan presents the background of the site, describes the rationale for each aspect of the investigation, and specifies the number and locations of sampling points.
- The Field Sampling Plan describes the details of the field procedures, such as soil boring procedures, monitoring well construction details, sampling techniques, aquifer testing and data analysis methodologies.
- The Site Specific Health and Safety Plan provides the field personnel with a description of procedures and personal protective equipment to be used for while conducting the field investigation.

Each of the documents has been developed in conformance with the appropriate U.S. EPA guidance documents. The Work Plan, Field Sampling Plan and Health and Safety Plan are attached to the Quality Assurance Project Plan as Appendices A, B, and C, respectively.

QUALITY ASSURANCE PROJECT PLAN (QAPP)
 REMEDIAL INVESTIGATION/FEASIBILITY STUDY
 WOODSTOCK MUNICIPAL LANDFILL
 WOODSTOCK, ILLINOIS

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SECTION 1 **PROJECT DESCRIPTION**

1.1 Site Description

The Woodstock Municipal Landfill site (Woodstock site) is located at the southern boundary of the city of Woodstock, Illinois. The site (approximately 40 acres) is located south of Davis Road, southwest of the intersection of U.S. Route 14 and Illinois Route 47 (see Figure 1). The civil rectangular coordinates for the site are northeast quarter of Section 17, Township 44 North, Range 7 East (NE 1/4, Sec 17, T44N, R7E).

The land surrounding the Woodstock site is a mixture of residential, agricultural, commercial and light industrial use. Land use immediately north of the site is primarily residential and agricultural. Land use west of the site is semi-agricultural with much of the land currently undeveloped. Land use east of the site is primarily commercial and light industrial with some areas remaining undeveloped. Kishwaukee Creek runs south along the southwestern perimeter of the site. The southwest portion of the site is mostly marshland. Small ponds and marshes also exist north of the site. The City of Woodstock wastewater treatment plant is located south of the site between the landfill boundary and the creek.

1.2 Site History

The Woodstock site was first used as a trash dump and open burning area from approximately 1935 until 1958. From 1958 to 1968, the site was used by the City as a household garbage and municipal landfill. Between 1968 and 1980, the property was used for the disposal of household garbage, municipal solid waste and various industrial solid wastes until it was covered and classified as closed by the Illinois Environmental Protection Agency (IEPA) on October 1, 1980. Following closure of the landfill in 1980, the City was granted a permit from IEPA to landfarm municipal sewage sludge at the site. In 1988, the City discontinued the application of sewage sludges to the landfill surface.

Little is known as to the identity and quantities of waste materials disposed of at the site. The materials reported to have been disposed of at the site include municipal waste, lime slurry and electroplating sludges containing primarily nickel, copper, cyanide and

chromium. Other potentially hazardous substances are reported to have been disposed at the landfill, including some combustible wastes. However, no determination can be made regarding any specific volume or type of waste materials which may have been disposed of in the landfill.

In March 1985, the U.S. EPA conducted a site investigation to evaluate the site by the Hazardous Ranking System (HRS) for inclusion on the National Priorities List (NPL). Factors causing the Woodstock site to be placed on the NPL were:

1. The reported disposal of hazardous substances at the site, and
2. The existence of a City well within 1.5 miles of the site.

Quarterly sampling of the Woodstock municipal wells for Primary Safe Drinking Water parameters and volatile organic compounds (VOC) has been conducted since 1986. Concentrations of measured parameters have been below maximum contaminant levels (MCLs) or were not detected.

During a July 13, 1988 the U.S. EPA's Technical Assistance Team (TAT), sampled three residential wells located on Dean Street, lying southwest of the facility; sample analysis indicated concentrations of arsenic, selenium and thallium in excess of the Safe Drinking Water Act (SDWA) maximum drinking water levels. The wells were re-sampled on December 22, 1988; although still detected, these metals were not found in excess of the SDWA levels.

The Woodstock Landfill Site was placed on the National Priorities List (NPL) by 40 CFR, Part 300, Volume 54, Number 191, dated October 4, 1989. A Statement of Work (SOW) was developed and included in an Administrative Order of Consent (AOC) between the U.S. Environmental Protection Agency (U.S. EPA) and a group of potentially responsible parties (PRPs). The effective date of the AOC was October 14, 1989.

The Work Plan (Appendix A) describes the activities proposed for the performance of the Remedial Investigation (RI) and Feasibility Study (FS) at the Woodstock Municipal Landfill. The Work Plan was prepared in accordance with the Administrative Order by

Consent (AOC), dated October 14, 1989, between the U.S. EPA and a group of potentially responsible parties (PRPs). A Statement of Work (SOW), dated August 30, 1989 was a part of the consent agreement and it established a conceptual framework for conducting the RI/FS.

1.3 Target Compounds

Leachate, groundwater and surface water will be analyzed for the Target Compound List (TCL) organic, the Target Analyte List (TAL) inorganic and water quality indicator parameters consisting of alkalinity, chloride, sulfate, total dissolved solids (TDS), total kjeldahl nitrogen (TKN), ammonia, nitrate + nitrite, chemical oxygen demand (COD) and total phosphorus. Field analysis will include measurements of pH, specific conductance, dissolved oxygen, oxidation-reduction potential (redox) and temperature.

Sediment samples will be analyzed for the TCL organic and TAL inorganic parameters, and Total Organic Carbon (TOC).

Water supply wells, if sampled, will be analyzed for TCL organics, TAL inorganics, water quality indicators and field measurements. However, analysis of TCL and TAL parameters will follow methods allowing for low level detection limits.

Refer to Appendix D for complete analyte lists and required detection limits.

1.4 Project Objectives

The purpose of the RI is to investigate the nature and extent of contaminants, if any, at the site. The objectives of the RI are to:

- Characterize the nature and extent of contamination and define the pathways of contaminant migration;
- Define the physical features that could affect contaminant migration, containment or remediation;
- Quantify risk to public health and the environment;
- Identify interim measure(s) that would positively mitigate immediate threats to human health or the environment; and
- Gather information necessary to support the FS.

Tasks, subtasks and activities are directed toward the accomplishment of these primary objectives. Refer to the Work Plan (Appendix A) for a detailed description of the RI tasks, subtasks and activities.

A summary of data generating activities, the intended data uses and data quality objectives (DQOs) for the site investigation are presented in Table 1.

1.5 Sample Network and Rationale

The activities and subtasks related to the field work are described in detail in the Work Plan (refer to Appendix A). Table 2 (this document) provides a listing of sample types, parameters and estimated number of samples. Table 3 summarizes sample quantities, containers, preservatives and packaging information.

1.6 Project Schedule

A schedule of RI/FS activities for the Woodstock site is summarized in Figure 2. A preliminary schedule of Field Activities is summarized in Table 4 of the Field Sampling Plan (Appendix B).

SECTION 2

PROJECT ORGANIZATION AND RESPONSIBILITY

2.1 Overall Responsibility

PRP Steering Committee Representative

- John Isbell
City of Woodstock
Woodstock, IL

U.S. EPA Remedial Project Manager

- Robert Swale
U.S. EPA Region V
Chicago, IL

PRP Project Director

- Daniel Hall, CPGS
Warzyn Engineering Inc.
Madison, WI

PRP Project Manager

- Peter Vagt, Ph.D.
Warzyn Engineering Inc.
Chicago, IL

Quality Assurance Officer (QAO)

- Gary Parker
Warzyn Engineering Inc.
Chicago, IL
- RI/FS Reports and technical memoranda prepared by Warzyn Engineering Inc.

2.2 Monitoring and Sampling Operations and QC

- Principal Engineering Firm - Warzyn Engineering Inc., Chicago, IL
- Drilling - to be determined through bidding process.
- Geophysics - Fromm Applied Engineering, Mequon, WI
- Field Soil Gas Screening - Tracer Research (or similar subcontractor)
- Sampling, Monitoring and Survey - Warzyn Engineering Inc., Chicago, IL
- Quality Control - QAO, Warzyn Engineering Inc., Chicago, IL

2.3 Laboratory Analyses and QC

- Analysis of groundwater, surface water, sediment and leachate samples for Target Compound List (TCL) organics using Contract Laboratory Program (CLP) protocols;
- Analysis of water supply wells for TCL organics using methods for low level detection limits found in Appendix E-8:

Compuchem
3308 Chapel Hill/Nelson Hwy.
Research Triangle Park, NC 27709

- Analysis of groundwater, surface water, sediment and leachate samples for Target Analyte List (TAL) inorganics using CLP protocols;
- Analysis of water supply wells for TAL inorganics using methods for low level detection limits found in Appendix E-1;
- Analysis of groundwater, surface water, water supply and leachate samples for water quality indicator parameters including alkalinity, chloride, sulfate, nitrate + nitrite, ammonia, TKN, TDS, COD and total phosphorus using procedures specified in Appendix E-2;
- Analysis of soil and sediments for cation exchange capacity using Appendix E-6:

Warzyn Engineering Inc.
One Science Court
Madison, Wisconsin 53711

- Analyses of soil and sediment samples to be evaluated for grain size, total porosity, Atterberg limits and permeability using procedures specified in Appendices E-3, E-4, E-5 and E-7:

EWI Engineering Inc.
505 Science Court
Madison, Wisconsin 53711

- Analysis of soil and sediment samples for Total Organic Carbon (TOC) using procedures specified in Appendix F:

RMT
744 Heartland Trail
Madison, Wisconsin 54708

- Analysis of landfill gas samples for Volatile Organic Compounds (VOCs) using the procedure summarized in Appendix E-9:

Enseco, Inc. - Air Toxics Laboratory
9537 Telstar Ave., Suite 118
El Monte, California 91731

Refer to Appendix D for complete analyte lists and their required detection limits for the laboratory analyses listed above.

2.4 Specialized Responsibility for Laboratory Analyses

- Compuchem Laboratory Data
 - Analytical protocol specified - Warzyn Engineering Inc., Madison, WI
 - Review of analytical protocol - Compuchem, Research Triangle Park, NC
 - Review of analytical protocol - U.S. EPA Region V Quality Assurance Section (QAS) and Central Regional Laboratory (CRL), Chicago, IL

- Internal QA/QC - Compuchem, Research Triangle Park, NC
- Final data review and validation - Warzyn Engineering Inc., Madison, WI
- Review of tentatively identified compounds and assessment of need for confirmation - Warzyn Engineering Inc., Madison, WI

- Warzyn Laboratory Data
 - Review of analytical specifications - U.S. EPA Region V QAS and CRL, Chicago, IL
 - Internal QA/QC - Warzyn Engineering Inc., Madison, WI
 - Final data review and validation - Warzyn Engineering Inc., Madison, WI

- EWI Laboratory Data
 - Review of analytical specifications - U.S. EPA Region V QAS and CRL, Chicago, IL
 - Internal QA/QC - EWI Engineering Inc., Madison, WI
 - Final data review - Warzyn Engineering Inc., Madison, WI

- RMT Laboratory Data
 - Review of analytical specifications - U.S. EPA Region V QAS and CRL, Chicago, IL
 - Internal QA/QC - RMT, Madison, WI
 - Final data review and validation - Warzyn Engineering Inc., Madison, WI

- Enseco Laboratory Data
 - Review of analytical specifications - U.S. EPA Region V QAS and CRL, Chicago, IL
 - Internal QA/QC - Enseco, El Monte, CA
 - Final data review and validation - Warzyn Engineering Inc., Madison, WI

2.5 Quality Assurance

- Overall QA Responsibility - QAO, Warzyn Engineering Inc., Chicago, IL
- QA for Warzyn Subcontracted Activities - Warzyn Engineering Inc., Chicago, IL
- Review of QAPP - U.S. EPA Region V QAS and CRL, Chicago, IL
- Field Analyses - Warzyn Engineering Inc., Chicago, IL

2.6 Performance and Systems Audits

- Field Operations
 - Internal Audits - QAO, Warzyn Engineering Inc., Chicago, IL
 - External Audits - U.S. EPA Region V CRL and Central District Office (CDO), Chicago, IL
- Analytical Laboratories
 - Internal Audits - QAO for each laboratory specified in Section 2.4
 - External Audits - U.S. EPA Region V CRL, Chicago, IL
- Final Evidence File Audits
 - Internal Audits - QAO, Warzyn Engineering Inc., Chicago, IL
 - External Audits - U.S. EPA Region V CRL, Chicago, IL

An organizational chart is provided in Figure 4.

SECTION 3
QUALITY ASSURANCE OBJECTIVES
FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY,
COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

The purpose of this section is to address the objectives of accuracy, precision, completeness, representativeness and comparability. Precision and accuracy are criteria for which quantitative limits can be developed. Precision describes the degree to which data generated from replicate or repetitive measurements differ. Accuracy is defined as the difference between the value of the reported data and the true value of the parameter being measured, and is assessed through the analysis of blanks, spikes, calibration standards and reference standards. The Quality Assurance (QA) objective with respect to precision and accuracy is to achieve the established limits for the analyses required. Completeness, representativeness and comparability are qualitative criteria used to determine the degree to which sample data accurately represents the site.

The overall QA objectives are to implement field sampling, chain-of-custody, and quality control reporting procedures that will provide legally defensible data from laboratory analyses in a court of law. Field analyses, including screening of samples for VOCs with an HNu and non-intrusive geophysical measurements, are being made primarily to aid in site selection for more detailed observations and analyses. Quality control objectives for these data, as well as those collected for health and safety purposes, are to obtain reproducible data consistent with limitations imposed by measurement methods used.

Specific procedures to be used for sampling, chain-of-custody, calibration, laboratory analyses, data reporting, internal quality control, audits, preventative maintenance, and corrective actions are described in other sections of this QAPP. This section (3.0) defines goals for the QC effort (accuracy, precision, and sensitivity of analyses and completeness, representativeness, and comparability) for data from analytical laboratories and presents quality control objectives for field measurements. A summary of data generating activities and associated data quality objectives is provided in Table 1. A summary of QC requirements for the analyses performed is provided in Table 4.

3.1 Level of Quality Control Effort

3.1.1 Field Sampling Program

The quality of data from the field sampling program for laboratory analyses will be evaluated through the collection of field duplicates, field blanks and trip blanks. Bottle blanks will also be analyzed to serve as a check for bottle contamination.

Duplicates will be used to assess the combined effects of sample collection, handling and analysis on data precision. The general level of effort for all matrices will be one field duplicate per 10 investigative samples.

Bottle blanks will be collected at a frequency of one per group of 100 or fewer samples in each bottle QC lot and will serve as a check for contamination in the sample containers. The bottle blank, to be prepared in the laboratory, will consist of deionized water poured into the bottle with the appropriate preservative added. The QC lot number will be clearly identified for each bottle blank. Pre-cleaned bottles will be purchased from I-Chem Research and Eagle Picher Environmental Services. The cleaning procedures used will be in accordance with the EPA document: "Specifications and Guidance for the Preparation of Contaminant-Free Sample Containers", U.S. EPA, April 1989.

Where appropriate, field blanks will be collected at a frequency of one per group of 10 or fewer samples per sample matrix per day. Field blank samples will serve as a check for procedural contamination or ambient conditions at the site that may result in apparent contamination of samples. Field blanks for samples not requiring filtration, will consist of deionized water passed through decontaminated sampling equipment. Field blanks for samples requiring filtration will consist of deionized water passed through decontaminated sampling equipment and filtering apparatus.

A trip blank (two 40 mL VOA vials filled with deionized water and preservative) will be included with each shipment of samples for volatile analysis. A shipment is to be considered a shipping unit; i.e., a single cooler. The purpose of a trip blank is to assess cross contamination in the shipment cooler of samples targeted for volatile organic analysis. Trip blanks will not be analyzed unless the field blank shows contamination. The trip blank will be prepared in the laboratory and will remain sealed during sampling activities.

For organics analyses, triple sample volume is required for matrix spike/matrix spike duplicate (MS/MSD) analyses at a frequency of one per twenty investigative samples.

3.1.2 Laboratory Analyses

Compuchem. Analysis of groundwater, surface water, leachate and sediment samples for TCL organics (see Appendix D for analyte list) will be performed by Compuchem using CLP protocols. Levels of QC effort for these analyses are described in CLP Statement of Work SOW 3/90 (or most current). Additional volumes will be collected in the field for the MS/MSD analyses at a frequency of one per twenty investigative samples.

Analysis of water supply wells for low level detection TCL organics (see Appendix D for analyte list) will be performed by Compuchem using methods found in Appendix E-8. Levels of QC effort are summarized in Table 4.

Warzyn. Analysis of groundwater, surface water, leachate and sediment samples for TAL inorganics (see Appendix D for analyte list) will be performed by Warzyn using CLP protocols. Levels of QC effort for these analyses are described in the CLP Statement of Work SOW 7/88 (or most current).

Analysis of water supply wells for low level detection TAL inorganics (see Appendix D for analyte list) will be performed by Warzyn using methods found in Appendix E-1. Levels of QC effort are summarized in Table 4.

Analysis of groundwater, surface water, water supply and leachate samples for general water quality indicator parameters (see Appendix D for analyte list) will be performed by Warzyn using the procedures specified in Appendix E-2. QC requirements will include, where applicable, matrix spikes, laboratory duplicates, blanks, calibration check standards and EPA reference samples. Required frequencies and acceptance limits are summarized in Table 4.

Analysis of soils and sediments for cation exchange capacity will be performed by Warzyn using the procedure specified in Appendix E-6. QC requirements will be limited to duplicate analyses.

EWI Engineering. Physical analyses, including Atterberg limits, grain size, total porosity and permeability will be performed by EWI Engineering using methods summarized in Appendices E-3, E-4, E-5 and E-6. Level of QC effort will be limited to duplicate analyses.

RMT. Analysis of soil and sediment samples for Total Organic Carbon (TOC) will be performed by RMT using the method specified in Appendix F. QC requirements and frequencies are summarized in Table 4.

Enseco. Analysis of landfill gas samples for VOCs (see Appendix D for analyte list) will be performed by Enseco using the method summarized in Appendix E-9. QC requirements and frequencies are summarized in Table 4.

3.1.3 Field Measurements

pH. Level of QC effort for the field measurement of pH will consist of precalibration using two certified buffer solutions, calibration checks and duplicate analyses using the procedure outlined in Appendix G-1. QC limits and frequencies are summarized in Table 4.

Specific Conductance. Level of QC effort for specific conductance measurements will consist of initial and continuing calibration checks and duplicate analyses using the procedure outlined in Appendix G-2. QC limits and frequencies are summarized in Table 4.

Dissolved Oxygen. Level of QC effort for dissolved oxygen measurements will consist of precalibration using the Air Calibration - Fresh Water method, continuing calibration checks and duplicate analyses using the procedure outlined in Appendix G-3. QC limits and frequencies are summarized in Table 4.

Reduction/Oxidation (Redox) Potential. Level of QC effort for Redox potential will consist of precalibration using quinhydrone saturated pH 4 and 7 buffer solutions and calibration checks using the quinhydrone saturated pH 4 buffer using the procedures outlined in Appendix G-4. QC limits and frequencies are summarized in Table 4.

Geophysical Measurements. Level of QC effort for geophysical measurements will consist of calibration as needed and repeated measurements for consistency of response. The EM survey will be performed using a Geonics EM-31-D operating in both the "in-phase" and "quadrature phase" modes. The EM-31-D operating in the in-phase mode is able to detect relative differences in an induced electromagnetic field. As such, absolute calibration of the instrument is not required. However, when the instrument is operated in the quadrature phase mode, a null calibration will be performed before each use as described in the users manual (refer to Appendix G-5).

The level of QC effort for geophysical measurements will be limited to duplication of measurements for consistent response and periodic calibration checks, if applicable. If response of repeated measurements are inconsistent, data will be considered unusable.

Field Screening. The level of QC effort for the field soil gas screening used to determine the placement of additional monitoring wells will be limited to calibration checks as described in the method found in Appendix G-6.

Water Elevation. Water elevations will be measured using an electronic water level indicator or a steel tape with a sounding device. Both devices make an audible sound in contact with liquid and will be used as a basis for measuring depth to groundwater. Quality control will be limited to averaging repeated measurements at each location.

Air Monitoring. Air monitoring will be conducted as part of the site safety air monitoring program which incorporates the use of photoionization (HNU), HCN Monitox, Gas-Tech and Radiation Alert Monitor meters. Method of calibration for the instruments are specified in Appendices G-7 through G-10.

3.2 Accuracy, Precision and Sensitivity of Analyses

The QA objectives for laboratory and field analyses with respect to accuracy, precision and sensitivity are to achieve acceptable data based on specified performance criteria. Accuracy and precision requirements and method detection limits for TCL organics are described in the CLP Statement of Work SOW 9/88. Accuracy and precision for TAL inorganics are described in CLP Statement of Work SOW 7/88. Accuracy and precision for general water quality parameters, low level detection TCL organics, low level detection TAL inorganics and analysis of landfill gas for VOCs are summarized in Table 4.

Precision of laboratory analyses is judged from results obtained from laboratory duplicate analyses. A method specific, minimum relative percent difference (RPD) (see section 12 for definition) is listed and will be used for assessing data quality. Data accuracy will be assessed based on results of U.S. EPA reference samples and of matrix spike analyses. Limits for EPA reference samples and minimum percent recovery (see section 12 for definition) for matrix spikes specified in Table 4, will be used for assessing data quality.

In addition to laboratory QC samples, field QC samples will also be collected. These will include both duplicate and blank samples. Variability in duplicate samples will reflect combined effects of both sampling and analytical error. No project specific maximum RPD has been set for field duplicate samples. Blank samples will be used to assess cross contamination associated with sampling activities. Again, no project specific maximum for results of blank samples has been established.

Accuracy of field measured pH will be judged from agreement of instrument readings with standard buffer solutions. Agreement with standards will be within 5% of the expected value and field measurements will be made to 0.01 pH unit. Measurement precision will be estimated by periodically (1 per 10 samples) making duplicate readings of samples. If the unit fails to calibrate, it will be replaced.

Accuracy of the conductivity meter will be assured by daily calibration checks with a standard of known concentration. If readings vary more than 5% from expected values, the unit will be replaced. Precision will be measured by making duplicate readings of samples at least every 10 samples.

Accuracy of the dissolved oxygen meter will be checked by daily calibration as suggested by the method specified in Appendix G-3. Measurement precision will be estimated by making duplicate readings of samples at least every 10 samples.

Accuracy of Redox potential will be judged from agreement of instrument reading with quinhydrone saturated buffer solutions. Agreement with standards will be within ± 10 mV of the expected value. Field measurements will be made to the nearest whole mV unit. Measurement precision will be estimated periodically (1 per 10 samples) by making duplicate readings of samples. If the unit fails to calibrate, it will be replaced.

Data needs for geophysical measurements require the ability to detect differences on a consistent relative scale. Hence, in most cases, an absolute calibration is not required. However, where applicable, instruments will be calibrated prior to use or be checked using manufacturer's suggested test procedures to monitor proper and consistent operation.

Accuracy of field instruments (HNu, HCN-Monitox, Radiation Alert Monitor and Gas-Tech) used for health and safety purposes will be checked by daily calibration. If units fail to calibrate, they will be replaced.

3.3 Completeness, Representativeness and Comparability

Completeness is defined as the proportion of data collected that meet project specific acceptance criteria. It is anticipated that at least 95% of the data collected will meet acceptance criteria. If required performance criteria are not met by performing laboratories, they will reanalyze samples if holding times permit. If holding times are exceeded, the performing laboratory will inform the Warzyn project manager. The Warzyn project manager shall, in turn, inform the U.S. EPA RPM so that a decision can be made as to what corrective action, if any, should be taken. The method of calculation for completeness is discussed in Section 12.

Sampling, preservation and analysis methods are designed to provide analysis results that are representative of the sample matrix at the point of collection. Warzyn recognizes the potential for considerable spatial heterogeneity in parameters measured at the site. Hence, the degree to which the sampled locations represent the population of potential sampling points cannot be stated precisely. Consequently, no quantitative expression of representativeness is proposed.

The analytical methods used are expected to provide data of comparable or greater quality with that previously collected and that which may be collected in subsequent project phases. Although data proposed for collection are judged to be of acceptable comparability, no quantitative expression of comparability is proposed.

SECTION 4

SAMPLING PROCEDURES

A Field Sampling Plan (FSP) has been prepared and is attached as Appendix B. The FSP contains sampling procedures and includes the following:

- Detailed procedures for the collection of samples for the required parameters;
- Detailed procedures for sample packaging, handling and shipment;
- Summary of sample container, reagent, preservative and hold time requirements;
- Chain-of-custody procedures;
- Detailed procedures for preparation/collection of trip blanks and field blanks;
- Documentation requirements of sampling activities (use of field log books, field measurement forms, etc.); and
- Summary of the sampling and analysis program.

Refer to Table 2 for sampling and analysis program and Table 3 for summaries of sample quantities, containers, preservatives, and packaging requirements.

SECTION 5

SAMPLE CUSTODY AND DOCUMENTATION

5.1 Chain-of-Custody Procedure for Field Activities

Samples will be collected under chain-of-custody procedures which will include the use of chain-of-custody forms, sample labels, sample tags, custody seals, sample identification records and field notebooks. Standard forms and field notebooks are to be maintained throughout the RI/FS sampling activities.

Field notebooks shall include information pertinent to the sampling episode. Field notebooks shall include, but not be limited to, sampling location and time, field measurements, weather conditions and sampling equipment used. Refer to the "Field Custody" and "Transfer of Custody and Shipment" sections of the Warzyn Chain-of-Custody Procedure found in Appendix H.

An example of the chain-of-custody form to be used is shown in Figure 5. Requirements are as follows:

- Fill out completely.
- One form per shipping container
- The carrier service does not need to sign the form if custody seals remain intact during shipment. (Note carrier and air bill number of the chain-of-custody.)
- Use for each sample collected.

Chain-of-custody seals are to be used for sample shipping. An example is shown in Figure

6. Seal requirements are as follows:

- Two (2) chain-of-custody seals are required per shipping container to secure the lid and provide evidence that the samples within have not been tampered with.
- Cover seals with clear tape prior to shipping sample containers.
- Record seal numbers on the chain-of-custody forms as well as the sample identification record forms.

A copy of the sample label to be used is shown in Figure 7. Label requirements are as follows:

- Each sample container must have a completed sample label affixed to it.
- Use for each sample.
- Use waterproof ink, unless prohibited by weather conditions.

An example of a sample tag is shown in Figure 8. Sample tag requirements are as follows:

- Each sample container must have a completed sample tag affixed to it.
- Record sample tag numbers on the chain-of-custody form and sample identification record form.
- Use for each sample.
- Use waterproof ink, unless prohibited by weather conditions.

An example of the Sample Identification Record Form to be used is shown in Figure 3. This form will provide means of recording crucial shipping and tracking information and will include such information as:

- Sample matrix
- Sample number
- Sample location code
- Sample round
- Laboratory code
- Sample tag number(s)
- Chain-of-custody number
- Date sampled
- Date shipped
- Airbill number

The documentation accompanying the samples shipped to the laboratory will be sealed in a plastic bag and taped to the inside of the cooler lid. The lid of the shipping container will be securely taped shut prior to shipment. Once in the laboratory's possession, sample custody will be the responsibility of the laboratory sample custodian.

Original field notes and field documents will be retained by Warzyn in a final evidence file.

5.2 Chain-of-Custody Procedure for Laboratory Analysis

Internal chain-of-custody procedures for Compuchem, Warzyn, Enseco and RMT are provided in Appendix H. Chain-of-custody forms, sample tags, data package and pertinent laboratory records shall be forwarded to Warzyn's final evidence file as permanent documentation of the analytical activities.

5.3 Final Evidence File

The format, contents and maintenance of Warzyn's final evidence file are given in Appendix I. The file custodian will be responsible for the maintenance of the file, while Warzyn's Quality Assurance Officer will be responsible for auditing the file.

SECTION 6

CALIBRATION PROCEDURES AND FREQUENCY

6.1 Field Calibration

Calibration methods of pH, specific conductance, dissolved oxygen (DO) and reduction/oxidation potential (Redox) meters is described in Appendices G-1 through G-4. Standard solutions will be used to calibrate the pH, specific conductance and Redox instruments. The DO meter will be calibrated using the Air Calibration-Fresh Water method as described.

Calibration of the HNu PI-10 (photoionization meter) will follow procedures recommended by the manufacturer (refer to Appendix G-7). The HNu will be calibrated to read in benzene equivalents at the beginning of each working day by using calibration gas (isobutylene) supplied by the manufacturer.

HCN Monitox detectors will be checked for accuracy each working day prior to use (refer to Appendix G-8). If the detector fails to calibrate, it will be replaced.

Calibration of the Gas-Tech Meter (for Methane gas testing) will follow procedures as recommended by the manufacturer (refer to Appendix G-9).

Calibration of the Radiation Alert Monitor will follow procedures recommended by the manufacturer (refer to Appendix G-10).

Instruments used for the geophysical survey will be calibrated or will undergo internal systems checks, as appropriate, prior to use, using methods recommended by the manufacturer. Background calibration measurements will be made prior to each survey, after four (4) hours, and at the end of each survey. These measurements will be made at the same location to provide "closed loops" of data values.

6.2 Laboratory Calibration

Procedures for the calibration and maintenance of measurement instruments must be established and maintained to ensure that equipment is functioning properly and that data collected are accurate and reliable. Requirements include step-by-step calibration procedures, frequency of re-calibration, equipment maintenance logs, instrument accuracy criteria, corrective action procedures and equipment limitations (e.g. working ranges), and are described, in detail, within the Standard Operating Procedures (SOPs) referenced below:

- TCL Organics - Refer to the CLP Statement of Work SOW 3/90 (or most current);
- Low Level Detection TCL Organics - Refer to the procedure outlined in Appendix E-8;
- TAL Inorganics - Refer to the CLP Statement of Work SOW 7/88 (or most current);
- Low Level Detection TAL Inorganics - Refer to the procedure outlined in Appendix E-1;
- Water Quality Indicators - Refer to specific procedures outlined in Appendix E-2;
- Total Organic Carbon - Refer to procedure outlined in Appendix F; and
- Analysis of Landfill Gas for VOCs - Refer to the procedure outlined in Appendix E-9.

SECTION 7

ANALYTICAL SERVICES

7.1 Laboratory Analytical Procedures

COMPUCHEM

Groundwater, surface water, sediment and leachate samples analyzed by Compuchem for TCL organics (see Appendix D for analyte list) will follow CLP protocols as outlined in the CLP Statement of Work SOW 3/90 (or most current).

Water supply samples analyzed by Compuchem for low level detection TCL organics (see Appendix D for analyte list) will follow procedures outlined in Appendix E-8.

WARZYN

Groundwater, surface water, sediment and leachate samples analyzed by Warzyn for TAL inorganic parameters (see Appendix D for analyte list) will follow CLP protocols outlined in the CLP Statement of Work SOW 7/88 (or most current).

Water supply samples analyzed by Warzyn for low level detection TAL inorganics (see Appendix D for analyte list) will follow procedures outlined in Appendix E-1.

Groundwater, surface water, water supply and leachate samples analyzed by Warzyn for general water quality parameters (see Appendix D for analyte list) will follow the procedures outlined in Appendix E-2.

Soil and sediment samples analyzed by Warzyn for cation exchange capacity will follow the procedure found in Appendix E-6.

EWI ENGINEERING

Soil samples for geotechnical parameters analyzed by EWI will follow the procedures outlined in Appendices E-3, E-4, E-5 and E-7.

RMT

Soil samples analyzed by RMT for Total Organic Carbon will follow the procedure outlined in Appendix F.

7.2 Field Analytical Procedures

WARZYN

Groundwater, surface water, water supply and leachate samples analyzed for pH, specific conductance, temperature, dissolved oxygen and redox potential will follow the procedures outlined in Appendices G-1 through G-4.

Health and safety monitoring using the HNu, HCN Monitox, Gas-Tech and Radiation Alert Monitor instruments will follow the procedures outlined in Appendices G-7 through G-10.

TRACER RESEARCH

Field soil gas screening will follow the procedure outlined in Appendix G-6.

FROMM APPLIED ENGINEERING

Geophysical surveys will be conducted using the procedure outlined in Appendix G-5.

SECTION 8

INTERNAL QUALITY CONTROL CHECK

Field

Required quality control checks for field measurements (pH, specific conductance, dissolved oxygen and redox potential) are summarized in Table 4, and include continuing calibration checks and duplicate measurements. Field quality control samples and their required frequency are specified in the FSP (Appendix B). Field quality control will include field blanks, trip blanks and field duplicates.

Laboratory

The overall objectives of internal quality control are to check the established precision, accuracy and integrity of the methodology and to support the technical validity of the data. Where appropriate, internal quality control checks for other than CLP-based analyses will include method blanks, preparation/reagent blanks, calibration check samples, laboratory duplicates, matrix spikes and continuing calibration standards. The required frequency and performance criteria for the non-CLP analyses are summarized in Table 4. Internal quality control check requirements for the TCL organics are summarized in Exhibit E of the CLP Statement of Work SOW 3/90 (or most current). Internal quality control check requirements for the TAL inorganics are summarized in Exhibit E of the CLP Statement of Work SOW 7/88 (or most current).

SECTION 9 **DATA REDUCTION, VALIDATION AND REPORTING**

9.1 Laboratory Analyses

Compuchem - TCL Organics using CLP Protocols

Specific procedures for identification, quantification, data reporting and required data deliverables for the TCL Organics are covered in Exhibit B of the CLP Statement of Work SOW 3/90 (or most current). Validation of the data will be performed by Warzyn using Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses, February 1988.

Compuchem - Low Level Detection TCL Organics

Specific procedures for identification and quantification are summarized in Appendix E-8. Data reporting and deliverables requirements will follow those specified for TCL organics using CLP protocols. Validation of the data will be performed by Warzyn using guidelines specified for TCL organics using CLP protocols, in conjunction with the performance criteria summarized in Table 4.

Warzyn - TAL Inorganics using CLP Protocols

Specific procedures for quantification, data reporting and required data deliverables for the TAL Inorganics are covered in Exhibit B of the CLP Statement of Work 7/88 (or most current). Data validation will be performed by Warzyn using Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, July 1988.

Warzyn - Low Level Detection TAL Inorganics

Specific procedures for quantification are summarized in Appendix E-1. Data reporting and deliverables requirements will be the same as those specified for TAL inorganics using CLP protocols. Validation of the data will be performed by Warzyn using guidelines specified for TAL inorganics using CLP protocols, in conjunction with the performance criteria summarized in Table 4.

Warzyn - General Water Quality Parameters

Specific procedures for the quantification are documented in the methods found in Appendix E-2. Deliverables for the indicators will include, where applicable, raw data, strip charts, results of calibration standards, duplicates, blanks, matrix spikes and performance evaluation samples. Data will be validated by Warzyn using the data validation procedure found in Appendix K, in conjunction with performance criteria summarized in Table 4. If performance criteria are met, data will be considered of acceptable quality. If performance criteria are not met, data will be considered estimated or unusable as discussed in the validation procedure.

RMT - Total Organic Carbon (TOC)

The specific procedure for the quantification of TOC is documented in the method found in Appendix F. Deliverables for this analysis will include raw data, instrument printouts, results of calibration standards, duplicates, blanks, matrix spikes and performance evaluation samples. Data will be validated by Warzyn using the data validation procedure found in Appendix K, in conjunction with the performance criteria summarized in Table 4. If performance criteria are met, data will be considered of acceptable quality. If performance criteria are not met, data will be considered estimated or unusable as discussed in the validation procedure.

Enseco - Analysis of Landfill Gas for VOCs

The specific procedure for identification and quantification of VOCs is documented in Appendix E-9. Required deliverables will include raw data, chromatograms, instrument printouts, results of calibration standards, duplicates, blanks, matrix spikes and performance evaluation samples. Data will be validated by Warzyn using Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses, February 1988, in conjunction with the QC criteria specified in Table 4.

9.2 Field Analyses

Field pH, Specific Conductance, Temperature, Dissolved Oxygen and Redox Potential

Data will be summarized, along with calibration verification, standardization and duplicate data on field bench sheets. Specific conductance data will be corrected to 25 degrees centigrade, as described in the procedure found in Appendix G-2. No formal

validation process will be performed, as this data is to be used for screening purposes only; however, the data will be reviewed by the field team leader to check that procedures are being followed and QC requirements are met.

Soil Gas Screening

Data will be summarized in a report format as specified in the procedure found in Appendix G-6. No formal validation process will be performed, as this data is to be used for screening purposes.

9.3 Field Sampling

Field duplicates will be collected at the appropriate frequencies noted in the FSP (Appendix B). The validation procedures described in section 9.1 address field duplicates and how they will be evaluated. Field blanks, trip blanks and bottle blanks will be collected at the appropriate frequencies noted in the FSP. Data quality will be assessed using the same criteria described in the validation procedures in section 9.1 for method blanks.

SECTION 10

PERFORMANCE AND SYSTEM AUDITS

External Audits

The U.S. EPA Region V CRL will audit performing laboratories and provide recommendations for approval of the laboratory for the requested analyses to the U.S. EPA RPM. The audit may consist of a review of analytical and chain-of-custody procedures, evaluation of performance samples, and may also include an on-site audit of each participating laboratory.

External audits of field activities may be performed by the EPA Region V CRL and CDO.

Internal Audits

The purpose of the internal laboratory audit is to evaluate and document adherence to analytical procedures described in this QAPP. Internal audits of Warzyn, Compuchem, Enseco and RMT are the responsibility of each individual laboratory and are conducted by that laboratory's QAO. Internal audit summaries and frequencies of each laboratory are found in Appendix J.

Internal field audits will be accomplished through unannounced site visits. The purpose of the field audit will be to evaluate and document adherence to procedures described in the QAPP and FSP. The audit will include review of field activities, sample tags, chain-of-custody forms, field notebooks and sampling and decontamination activities. A description of the audit to be performed is included in Appendix J. Internal field audits will be performed at a frequency of at least one per project phase.

A summary of the internal field audit results will be included in scheduled progress reports. Summaries of internal laboratory audits will be provided upon request. Data validation of the data received, along with the external audit performed by the U.S. EPA Region V CRL will provide sufficient information to document and evaluate adherence to analytical procedures of the subcontracted laboratories.

SECTION 11

PREVENTATIVE MAINTENANCE

Preventative maintenance procedures for field instrumentation including pH, specific conductance, dissolved oxygen, redox potential, EM survey, field soil gas screening, and health and safety monitoring are detailed in the instrument manuals in Appendices G-1 through G-10. Field instruments will be checked and calibrated daily. Batteries will be checked and recharged as necessary. Spare parts (HNu lamps, batteries, etc.) will be kept on-site to minimize "down time" of the field instruments.

Preventative maintenance procedures for laboratory instrumentation and equipment for TCL organics (including low level TCL organics) are referenced in Exhibit E of the CLP Statement of Work SOW 3/90 (or most current). TAL inorganics preventative maintenance procedures are referenced in Exhibit E of the CLP Statement of Work SOW 7/88 (or most current).

Preventative maintenance of laboratory instruments associated with the indicator (including TOC) and low level detection TAL inorganics analyses will be as directed in factory manuals, instrument operating procedures, and analytical methods. Periodic maintenance by factory representatives will be performed. Daily logs documenting use and maintenance activities are retained in the laboratory. Refer to Appendix L for Warzyn's daily instrument QC check procedure.

Preventative maintenance of laboratory instruments associated with VOC analysis of landfill gas is summarized within the procedure found in Appendix E-9.

SECTION 12
SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION,
ACCURACY, AND COMPLETENESS

Assessment of accuracy, precision and completeness for analyses based on CLP protocols will follow specifications stated in the CLP Statement of Work. Accuracy and precision definitions for analysis of general water quality indicator parameters and TOC are specified in the method descriptions found in Appendices E and F.

Assessment of accuracy precision and completeness of analytical data is based on the acceptable results of QC samples. Where appropriate, these include blanks, duplicate samples, laboratory control spikes and matrix spike duplicates.

Method, field, trip blank and bottle blank results are expected to provide a measured value that is less than or equal to the reported detection limit.

Field and laboratory duplicate sample results are assessed based on relative percent difference (RPD) between values, using the following equation:

$$RPD = \frac{(D1 - D2)}{(D1 + D2)/2} \times 100$$

where, D1 = first sample value
D2 = Second sample value (duplicate)

Laboratory control spike results are assessed based on the percent recovery (%R) of fortified analytes. Percent recovery is calculated using the following equation:

$$\%R = \frac{Q_d}{Q_a} \times 100$$

where, Q_d = Quantity determined by analysis
Q_a = Quantity added to sample.

Matrix spike/matrix spike duplicate data are assessed based on %R of fortified analytes using the following equation:

$$\%R = \frac{(SSR - SR)}{SA} \times 100$$

where, SSR = Spike Sample Result
SR = Sample Result
SA = Spike Added

Relative percent difference (RPD) between matrix spike and matrix spike duplicate is calculated using the same equation for RPD described above.

Data completeness is the percentage of data meeting acceptance criteria. It is calculated using the following equation:

$$\text{Completeness} = \frac{N_1}{N_2} \times 100$$

where, N_1 = Number of Acceptable Observations
 N_2 = Total Number of Observations Required or Expected Under Normal Conditions

SECTION 13

CORRECTIVE ACTION

Corrective action must be initiated whenever a system is out of control. If quality control audits (laboratory or field) result in the detection of unacceptable conditions or data, *steps of recommending, approving and implementing corrective action must be taken.* Appropriate personnel must be involved in approving and implementing the corrective action.

Corrective action for the analytical laboratories (Warzyn, Compuchem, Enseco and RMT) is addressed in the laboratory audit procedures found in Appendix J. Any problems which cannot be resolved at the laboratory level by the analyst, supervisor or laboratory QAO, *will be brought to the attention of the Warzyn project manager. The Warzyn project manager and the U.S. EPA RPM will determine what corrective action, if any, will be taken.*

If problems arise in the field which cannot be resolved at the field supervisory level, the situation will be brought to the attention of the Warzyn project manager. The Warzyn project manager and the U.S. EPA RPM will determine what corrective action, if any, will be required.

SECTION 14
QUALITY ASSURANCE REPORTS TO MANAGEMENT

Monthly progress reports submitted to U.S. EPA and IEPA will include a summary of the qualified sampling and analysis activities for the month. Monthly progress reports will also include any QA problems encountered along with the corrective action proposed or already taken. Results of any field audits conducted within the past month will be included in the monthly progress reports.

Technical memoranda will be prepared to describe the procedures used to collect the data, and will present the data. The final RI report will contain separate sections that will summarize the data quality. The contents of the monthly progress reports, technical memoranda and RI reports are described in further detail in the Work Plan (Appendix A, Section 5, Task 10).

APPENDIX A

WORK PLAN

TABLE 1
SUMMARY OF DATA GENERATING ACTIVITIES AND ASSOCIATED DATA QUALITY OBJECTIVES
WOODSTOCK MUNICIPAL LANDFILL

<u>ACTIVITY</u>	<u>TASK</u>	<u>DESCRIPTION</u>	<u>INTENDED DATA USAGES</u>	<u>ANALYSIS PARAMETERS</u>	<u>DATA QUALITY OBJECTIVE (ANALYTICAL LEVEL)</u>	<u>ANTICIPATED NO. OF INVESTIGATIVE SAMPLES</u>
<u>SOURCE CHARACTERIZATION</u>						
Methane Gas Surveys	6A, 6C, 6G	Measure ambient levels of methane, measurement of gas emanating from monitoring wells and leachate head wells.	To survey and evaluate methane production and gas concentrations.	Methane Gas survey using Gas-Tech or similar instrument.	Level II Data	0
Landfill Gas Sampling	6D, 6G	Measurement of gas emanating from leachate head well showing the highest HNu readings.	To characterize the landfill gas and determine the potential risk from airborne contaminants.	Analysis of landfill gas for VOCs.	Level III Data	2
Geophysical Survey	6B	Electromagnetic (EM) Survey conducted adjacent to the landfill.	To attempt to identify possible leachate seeps and groundwater contamination, to map anomalies in an area where containerized waste may have been disposed, and to delineate the extent of the filled area.		Level I Data	0
Test Borings	6D	Borings extended through the entire thickness of the refuse. Possible collection of additional core samples from landfill surface to refuse.	Documentation of refuse thickness, placement of the leachate head wells and/or gas vents, and evaluation of the thickness and physical characteristics of the clay cap.	Analysis of borings for permeability, grain size, and atterberg limits.	Level III Data	5-20 Soil Borings
Leachate Sampling	6D	Sampling of the leachate head wells (2 rounds).	Determine the chemical characteristics of the leachate in the landfill.	Analysis of leachate samples for TAL, TCL, indicator parameters, and COD.	Level IV Data for TAL and TCL Level III Data for Indicators	5 Leachate Head Wells

TABLE 1
(CONTINUED)

ACTIVITY	TASK	DESCRIPTION	INTENDED DATA USAGES	ANALYSIS PARAMETERS	DATA QUALITY OBJECTIVE (ANALYTICAL LEVEL)	ANTICIPATED NO. OF INVESTIGATIVE SAMPLES
MIGRATION PATHWAY ASSESSMENT						
Geologic Characterization	6C	Collection of soil borings to represent the upper sand and gravel, the lower sand and gravel lens, and the clay till separating the two sand and gravel zones.	To document the geologic stratigraphy in the vicinity of the landfill, and to aid in developing the geologic characterization of the site.	Analysis of soil borings for grain size, cation exchange capacity, total porosity, atterberg limits, TOC and vertical permeability.	Level III Data	9 Soil Borings (3 Soil Borings for permeability)
Groundwater Flow Characterization	6C	Water level measurements at staff gages, head wells and monitoring wells.	To evaluate the potential groundwater flow paths.		Level I Data	0
Aquifer Tests	6C	Aquifer tests conducted at each monitoring well.	To aid in the analysis of spatial variations or trends in hydraulic conductivity beneath the site. Estimate groundwater flow rates.			0
Monitoring Well Installation and Sampling	6C	Installation of 6 2-well nests surrounding the landfill, and collection of the 2 rounds of samples at each of the 12 monitoring wells.	To determine the vertical and horizontal extent of any contaminant plume originating from the landfill.	Analysis of groundwater samples for TAL, TCL and indicator parameters.	Level IV Data for TCL and TAL Level III Data for Indicators	12 Monitoring Wells
Additional Well Installation/Sampling	6C	Installation of an estimated 10 additional wells and 2 rounds of sampling at each well.	To further evaluate the extent of the contaminant plume.	Analysis of groundwater samples for TAL, TCL and indicator parameters.	Level IV Data for TCL and TAL Level III Data for Indicators	10 Monitoring Wells
Sediment/Surface Water Investigation	6F	Collection of sediment samples to represent both surface water migration pathways. Possible collection of surface water samples.	To determine if runoff or or leachate leakage has impacted areas surrounding the site. Evaluate the extent of the impact, if it has occurred.	Analysis of sediments for TAL and TCL parameters. Analysis of sediments for grain size, CEC, porosity and TOC.	Level IV Data for TAL and TCL Level III Data for grain size, CEC, porosity and TOC.	8 Sediments (4 Sediments for physical analyses)
Collection of Sample Discharging into the Kishwaukee Creek	6F	Collection of a sample of the liquid observed discharging into the Kishwaukee Creek.	To determine if contaminants are migrating into the creek.	Analysis of water sample for TAL and TCL parameters.	Level IV Data	1 Water sample

TABLE 1
(CONTINUED)

<u>ACTIVITY</u>	<u>TASK</u>	<u>DESCRIPTION</u>	<u>INTENDED DATA USAGES</u>	<u>ANALYSIS PARAMETERS</u>	<u>DATA QUALITY OBJECTIVE (ANALYTICAL LEVEL)</u>	<u>ANTICIPATED NO. OF INVESTIGATIVE SAMPLES</u>
<u>MIGRATION PATHWAY ASSESSMENT</u>		(continued)				
Wetland Delineation	6H	Delineation performed in the northeastern and southwestern parts of the site during the vegetation growing season.	Locate wetland boundaries and evaluate the wetland quality.			0

CAM/caw/KJD/DWH

TABLE 2
SAMPLE TYPE AND ESTIMATED SAMPLE NUMBERS
WOODSTOCK MUNICIPAL LANDFILL

<u>SAMPLE (1)</u> <u>MATRIX</u>	<u>LAB (2)</u>	<u>NO. OF</u> <u>SAMPLES</u>	<u>FIELD (4)</u> <u>DUPLICATES</u>	<u>FIELD (3)</u> <u>BLANKS</u>	<u>TOTAL NO.</u> <u>SAMPLES</u>	<u>LAB (5)</u> <u>PARAMETERS</u>	<u>FIELD</u> <u>PARAMETERS</u>
<u>SOURCE CHARACTERIZATION</u>							
Leachate Monitoring (Round 1)	Warzyn	5	1	1	7	TAL-Metals Cyanide Cl, SO4, TKN, NH3, NO3+NO2, TDS, Total Phosphorus, COD TCL-Organics	Temperature, pH, Conductivity, Dissolved Oxygen, Redox
	Warzyn	5	1	1	7		
	Warzyn	5	1	1	7		
	Compuchem	5	1	1	7		
Soil Borings	EWI	5	1	0	6	Grain Size, Atterberg Limits, Permeability	
Methane Gas Survey	N/A	5	N/A	N/A	5	N/A	Percent gas
Landfill Gas	Enseco	2	1	1	4	VOCs	
Geophysical Survey	N/A	TBD	TBD	N/A	TBD	N/A	Conductivity
<u>MIGRATION PATHWAY ASSESSMENT</u>							
Groundwater Monitoring (Round 1)	Warzyn	12	2	2	16	TAL-Metals Cyanide Alk, Cl, SO4, TKN, NH3, NO3+NO2, TDS, Total Phosphorus TCL-Organics	Temperature, pH, Conductivity, Dissolved Oxygen, Redox
	Warzyn	12	2	2	16		
	Warzyn	12	2	2	16		
	Compuchem	12	2	2	16		
Bail Tests	N/A	12	N/A	N/A	12	N/A	Hydraulic Conductivity
Soil Borings	EWI	9	1	0	10	Grain Size, CEC, Porosity	
	RMT	9	1	0	10	Permeability TOC	
Sediments	EWI	4	1	0	5	Grain Size, CEC, Porosity TOC	
	RMT	4	1	0	5		
	Warzyn	8	1	0	9	TAL-Metals	
	Warzyn	8	1	0	9	Cyanide	
	Compuchem	8	1	0	9	TCL-Organics	

TABLE 2
(Continued)

<u>SAMPLE (1)</u> <u>MATRIX</u>	<u>LAB (2)</u>	<u>NO. OF</u> <u>SAMPLES</u>	<u>FIELD (4)</u> <u>DUPLICATES</u>	<u>FIELD (3)</u> <u>BLANKS</u>	<u>TOTAL NO.</u> <u>SAMPLES</u>	<u>TEST (5)</u> <u>PARAMETERS</u>	<u>FIELD</u> <u>PARAMETERS</u>
<u>MIGRATION PATHWAY ASSESSMENT</u> (continued)							
Surface Water	Warzyn	1	1	1	3	TAL-Metals	
	Warzyn	1	1	1	3	Cyanide	
	Compuchem	1	1	1	3	TCL-Organics	
<u>CONTAMINANT CHARACTERIZATION</u>							
Leachate Monitoring (Round 2)	Warzyn	5	1	1	7	TAL-Metals	Temperature, pH, Conductivity, Dissolved Oxygen, Redox
	Warzyn	5	1	1	7	Cyanide	
	Warzyn	5	1	1	7	Cl, SO4, TKN, NH3, NO3+NO2, TDS, Total Phosphorus, COD	
	Compuchem	5	1	1	7	TCL-Organics	
Groundwater Monitoring (Round 2)	Warzyn	12	2	2	16	TAL-Metals	Temperature, pH, Conductivity, Dissolved Oxygen, Redox
	Warzyn	12	2	2	16	Cyanide	
	Warzyn	12	2	2	16	Alk, Cl, SO4, TKN, NH3, NO3+NO2, TDS, Total Phosphorus	
	Compuchem	12	2	2	16	TCL-Organics	
Groundwater Monitoring (New Wells, 2 Rounds)	Warzyn	10	1	1	12	TAL-Metals	Temperature, pH, Conductivity, Dissolved Oxygen, Redox
	Warzyn	10	1	1	12	Cyanide	
	Warzyn	10	1	1	12	Alk, Cl, SO4, TKN, NH3, NO3+NO2, TDS, Total Phosphorus	
	Compuchem	10	1	1	13	TCL-Organics	
Bail Tests	N/A	10	N/A	N/A	10	N/A	Hydraulic Conductivity

TABLE 2
(Continued)

Notes:

1. Samples will be considered low or medium concentration.
2.

Cumpchem	Warzyn Engineering Inc.	RMT
3308 Chapel Hill/Nelson Hwy	One Science Court	744 Heartland Trail
Research Triangle Park, NC 27709	Madison, WI 53705	Madison, WI 54708
Enseco, Inc. Air Toxics Laboratory	EWI Engineering Inc.	
9537 Telstar Ave, Suite 118	505 Science Court	
El Monte, CA 91731	Madison, WI 53705	
3. A trip blank for VOC analysis will be included with each cooler shipped for leachate and groundwater samples.
4. Extra volume is required for the TCL organic MS/MSD quality control requirement (triple volume for VOC, double volume for BNAs and Pesticides/PCBs). TAL inorganics and general water quality indicator parameters do not require additional sample volume to meet the specified QC.
5. See Appendix D for EPA TCL and TAL analyte lists.

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TABLE 3

SAMPLE QUANTITIES, CONTAINERS, PRESERVATIVES AND PACKAGING FOR
SAMPLES FROM THE WOODSTOCK MUNICIPAL LANDFILL

<u>Analysis</u>	<u>Bottles and Jars</u>	<u>Preservation</u>	<u>Holding Time (2)</u>	<u>Volume of Samples</u>	<u>Shipping</u>	<u>Normal Packaging (1)</u>
<u>WATER AND LIQUIDS</u>						
<u>Low Concentration (Organics)</u>						
Acid extractables, base/neutral extractables	2 1-Liter amber	Iced to 4°C	5 days until extraction, 40 days from VTSR	Fill bottle to neck	Shipped daily by overnight carrier	Vermiculite
Pesticides/PCBs	2 1-Liter amber	Iced to 4°C	5 days until extraction, 40 days from VTSR	Fill bottle to neck	Shipped daily by overnight carrier	Vermiculite
Volatiles	Two 40-mL volatile organic analysis (VOA) vials	1:1 HCL (2 drops/vial) Iced to 4°C (do not preserve leachate)	10 days from VTSR (7 days from sampling date for leachate)	Fill completely no headspace	Shipped daily by overnight carrier	Vermiculite
<u>Low Concentration (Inorganics)</u>						
Metals	1 liter high density polyethylene bottle	Field filter through 0.45 um filter HNO ₃ to pH<2 Iced to 4°C (leachate, surface water and private well samples will be unfiltered)	180 days (26 days for Hg) from VTSR	Fill to shoulder of bottle	Shipped daily by overnight carrier	Vermiculite
Cyanide	2 1-liter high density polyethylene bottle	NaOH to pH>12 Iced to 4°C	12 days from VTSR	Fill to shoulder of bottle	Shipped daily by overnight carrier	Vermiculite
<u>Water Quality Parameters</u>						
TKN, Nitrate + Nitrite-N, Ammonia, T. Phosphorus, COD	1 liter high density polyethylene bottle	H ₂ SO ₄ to pH<2 Iced to 4°C	28 days from sampling date	Fill to shoulder of bottle	Shipped daily by overnight carrier	Vermiculite
Alkalinity, chloride, sulfate	One 500-mL polyethylene bottle	Iced to 4°C	28 days (14 days for alkalinity) from sampling date	Fill to shoulder of bottle	Shipped daily by overnight carrier	Vermiculite
TDS	One 500-mL polyethylene bottle	Field filter through 0.45 um filter, Iced to 4°C (surface water and private well samples will be unfiltered)	7 days from sampling date	Fill to shoulder of bottle	Shipped daily by overnight carrier	Vermiculite

TABLE 3
(Continued)

<u>Analysis</u>	<u>Bottles and Jars</u>	<u>Preservation</u>	<u>Holding Time(2)</u>	<u>Volume of Samples</u>	<u>Shipping</u>	<u>Normal Packaging (1)</u>
<u>SOILS AND SOLIDS</u>						
<u>Low or Med Concentration (Organics)</u>						
Acid extractables, base/neutral extractables, pesticides/PCBs	Two 8-oz wide mouth glass jar	Iced to 40C	10 days until extraction, 40 days from VTSR	Fill 3/4 full	Shipped daily by overnight carrier	Vermiculite (Med in cans/vermiculite)
Volatiles	Two 4-oz wide mouth glass vials	Iced to 40C	10 days from VTSR	Fill Completely no headspace	Shipped daily by overnight carrier	Vermiculite (Med in cans/vermiculite)
<u>Low or Med Concentration (Inorganics)</u>						
Metals and Cyanide	One 8-oz wide mouth glass jar	Iced to 40C	6 months (26 days Hg) (12 days CN) from VTSR	Fill 3/4 full	Shipped daily by overnight carrier	Vermiculite (Med in cans/vermiculite)
Total Organic Carbon	One 8-oz wide mouth glass jar	Iced to 40C	28 days from sampling date	Fill 3/4 full	Shipped daily by overnight carrier	Vermiculite
<u>Physical Analyses</u>						
Grain size, moisture content	Two 8-oz wide mouth glass jar	NONE	Not established	Fill 3/4 full	Ship by carrier	Vermiculite
Cation exchange capacity	Two 8-oz wide mouth glass jar	NONE	Not established	Fill 3/4 full	Ship by carrier	Vermiculite
Atterberg limits, Permeability, Total porosity	3-in Shelby tube	NONE	Not established	Fill 3/4 full	Ship by carrier	Vermiculite/ upright position upright position
<u>LANDFILL GAS</u>						
Volatile Organic Compounds	One canister	see Method in Appendix E-9	Not established	See Method in Appendix E-9	Shipped daily by overnite carrier	Vermiculite/ upright position

Notes:

(1) The packing material should completely cushion the sample bottles - bottom, sides and top.

(2) VTSR - verified time of sampling receipt.

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TABLE 4
SUMMARY OF QUALITY CONTROL REQUIREMENTS FOR ANALYSES
PERFORMED AT THE WOODSTOCK MUNICIPAL LANDFILL

PARAMETER	AUDIT	FREQUENCY¹	LIMITS²
TCL Organics	Refer to SOW 3/90 (or most current)		
TAL Inorganics	Refer to SOW 7/88 (or most current)		
TCL Organics (Low Detection Limits for Water Supply Wells)	Refer to Appendix E-8		
TAL Inorganics (Low Detection Limits for Water Supply Wells)	Requirements per SOW 7/88 (or most current)		
Volatile Organics (Leachate Gas)	Check Standard	One standard containing all target compounds (after initial tuning)	90 % of the target compounds must be within ± 30 % of the three point calibration curve.
	Lab Control and Duplicate Control Sample (containing five specified compounds)	1 per 20 samples	85-115 % and <20 % RPD (for all 5 compounds)
	System Blank	1 per 20 samples	All compounds < MDL
Alkalinity, Chloride, COD, Sulfate, NO₂ + NO₃	Lab Blank	1 per 10 samples	< Detection Limit (DL)
	Check Standard	1 per 10 samples	90-110 % Recovery
	EPA QC Reference Standard	1 per set	85-115 % Recovery
	Lab Duplicate	1 per 10 samples	10 % RPD (± 2 xDL if sample concentration is <5 x DL)
	Matrix Spike	1 per 10 samples	85-115 % Recovery

TABLE 4
(continued)

<u>PARAMETER</u>	<u>AUDIT</u>	<u>FREQUENCY</u> ¹	<u>LIMITS</u> ²
Ammonia Nitrogen, TKN, Total Phosphorus	Lab Blank	1 per 10 samples	< DL
	Preparation Blank	1 per set	< DL
	Check Standard	1 per 10 samples	90-110 % Recovery
	EPA QC Reference Standard	1 per set	85-115 % Recovery
	Lab Duplicate	1 per 10 samples	10 % RPD (\pm 2xDL if sample concentration is $<5 \times$ DL)
	Matrix Spike	1 per 10 samples	85-115 % Recovery
Total Dissolved Solids	Lab Blank	1 per set	< DL
	EPA QC Reference Standard	1 per set	80-120 % Recovery
	Lab Duplicate	1 per 10 samples	10 % RPD (\pm 2xDL if sample concentration is $<5 \times$ DL)
Total Organic Carbon	Lab Blank	1 per 10 samples	< DL
	Check Standard	1 per 10 samples	90-110 % Recovery
	EPA QC Reference Standard	1 per set	80-120 % Recovery
	Lab Duplicate	1 per 10 samples	20 % RPD (\pm DL if sample concentration is $<5 \times$ DL)
	Matrix Spike	1 per 10 samples	75-125 % Recovery

TABLE 4
(continued)

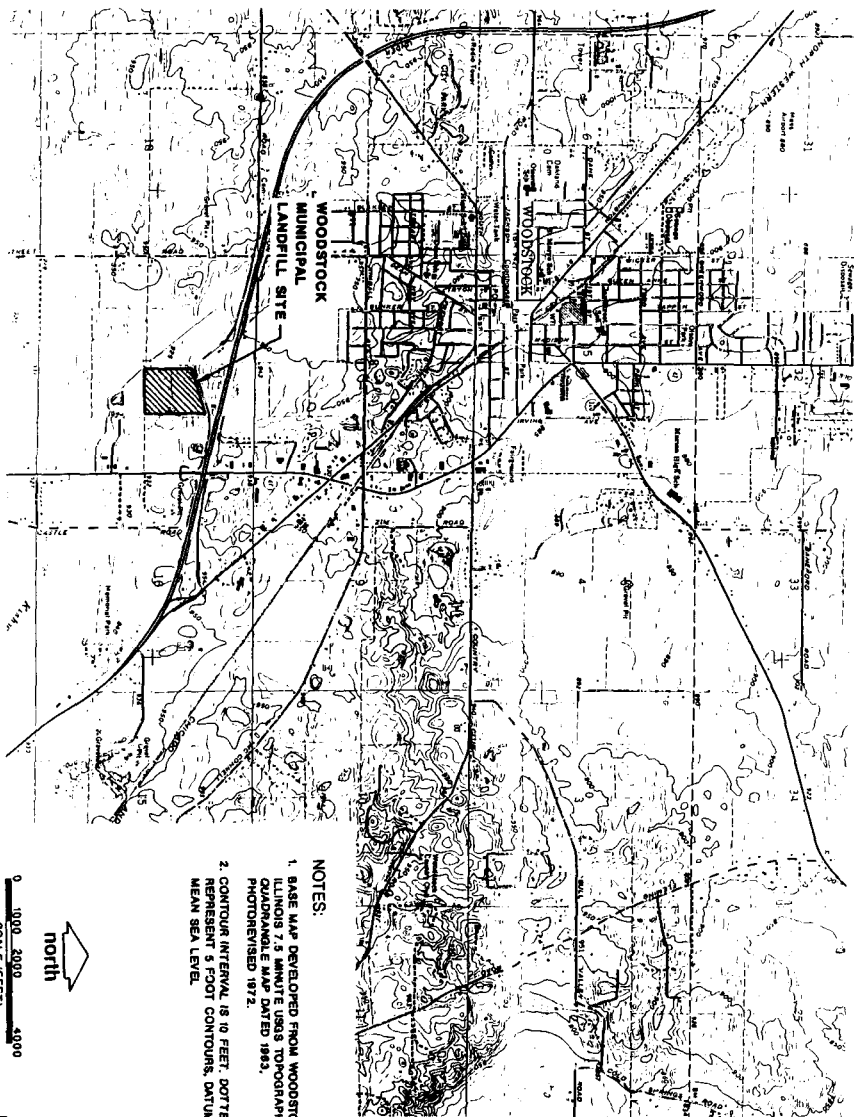
<u>PARAMETER</u>	<u>AUDIT</u>	<u>FREQUENCY</u> ¹	<u>LIMITS</u> ²
Grain Size, Atterberg Limits weight	Lab Duplicate	1 per 10 samples	10 % RPD or <2% by
Cation Exchange Capacity	Lab Duplicate	1 per 10 samples	15 % RPD
Permeability, Total Porosity	Lab Duplicate	1 per 10 samples	50 % RPD
Field pH	Check Standard	1 per 10 samples	± 5% of true value
	Duplicate	1 per 10 samples	± 0.2 pH unit
Field Specific Conductance	Check Standard	1 per 10 samples	90-110 % Recovery
	Duplicate	1 per 10 samples	20 % RPD (± 2xDL if sample concentration is <5 x DL)
Field Dissolved Oxygen	Duplicate	1 per 10 samples	20 % RPD
Field Redox Potential	Check Standard	1 per 10 samples	± 10 MV of true value
	Duplicate	1 per 10 samples	20 % RPD

Notes:

1 Frequencies apply to each matrix.

2 Refer to Appendix D for required detection limits for each analyte.

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NOTES:

1. BASE MAP DEVELOPED FROM WOODSTOCK, ILLINOIS 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE, DATED 1983, PHOTOENLARGED 1972.
2. CONTOUR INTERVAL IS 10 FEET. DOTTED LINES REPRESENT 5 FOOT CONTOURS, DATUM IS MEAN SEA LEVEL.

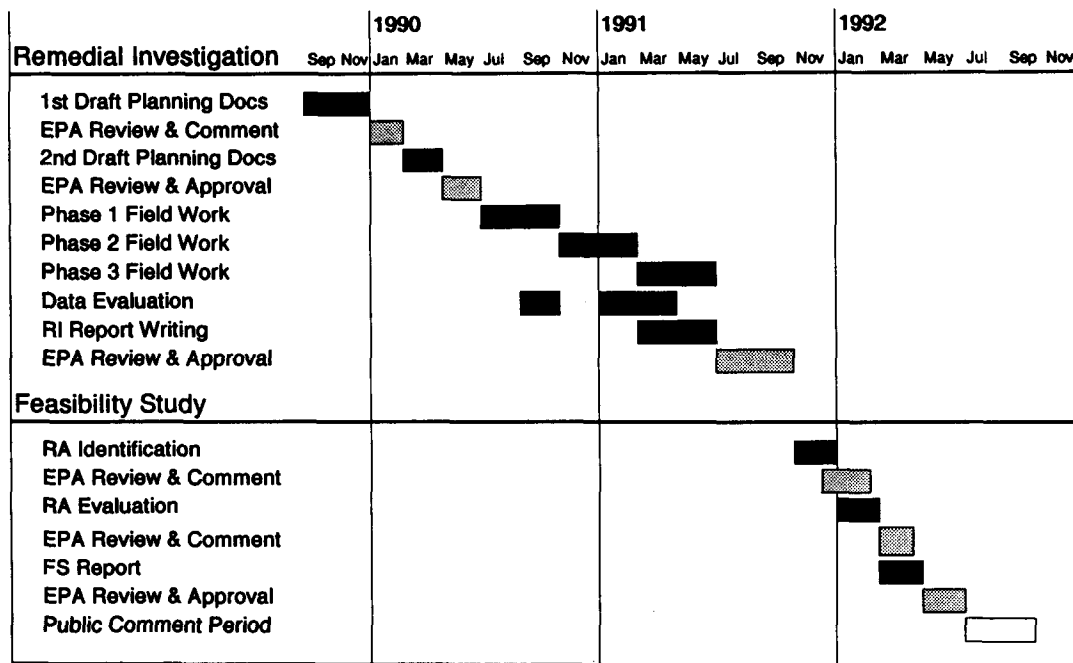
0 1000 2000 4000
SCALE (FEET)



FIGURE 1

	SITE LOCATION MAP		WARZYN <small>ENGINEERING & CONSULTING, INC.</small> <small>1000 N. W. 10th St., Suite 100, Ft. Lauderdale, FL 33304</small> <small>Phone: (305) 555-1234 Fax: (305) 555-1235</small>		Drawn By: <i>FW</i>	Check By: <i>OLL</i>	Entered By: <i>TWP</i>
	WORK PLAN REMEDIAL INVESTIGATION/FEASIBILITY STUDY WOODSTOCK MUNICIPAL LANDFILL SITE WOODSTOCK, ILLINOIS			Approved By: <i>SA-001</i>	Date: <i>12/1/12</i>	Revision:	

Figure 2. PROJECT SCHEDULE



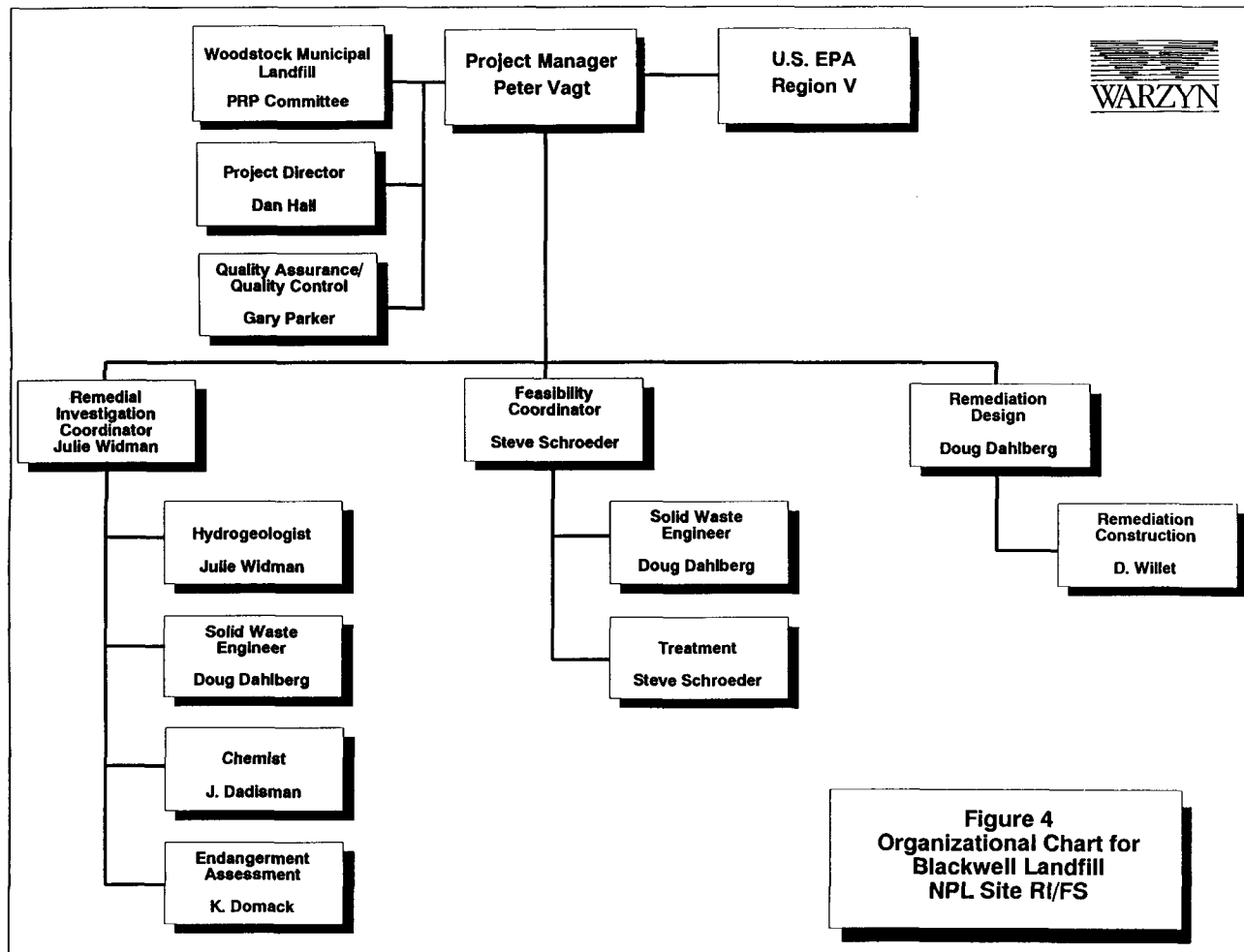
Key:



Agency review periods may vary.

[illegible]

Figure 3. Sample Identification





Nº 87.5019

CHAIN OF CUSTODY SEAL

**WARZYN ENGINEERING INC.
ONE SCIENCE COURT
UNIVERSITY RESEARCH PARK
P.O. BOX 5385
MADISON, WI 53705
(608) 273-0440**

Figure 6. Chain-of-Custody Seal

Project #	_____	Lab #	_____
Sample Description	_____		
Date Collected	_____	By	_____
Preservative:	HNO ₃	H ₂ SO ₄	NaOH
	Filtered	None	Other _____
			Unfiltered

Figure 7. Sample Label

Figure 8. Sample Tag

APPENDIX A

WORK PLAN

WORK PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WOODSTOCK MUNICIPAL LANDFILL
WOODSTOCK, ILLINOIS
(June 8, 1990)

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SECTION 1 INTRODUCTION

The planning documents for the RI/FS at the Woodstock Site consist of a Quality Assurance Project Plan (QAPP), a Work Plan (WP), a Field Sampling Plan (FSP), and a site specific Health and Safety Plan (HSP). Each of the plans has a specific purpose, and efforts have been made to avoid duplication of focus in the documents. This document is the Work Plan; its purpose is to present the background of the site, describe the rationale for each aspect of the investigation, provide the direction of the RI/FS, and plan the number and locations of sampling points. The purposes of the other documents are as follows:

- The Quality Assurance Project Plan describes the specific protocols which will be followed for sampling, sample handling and storage, chain-of-custody, and laboratory (or field) analysis.
- The Field Sampling Plan describes the details of the field procedures, such as soil boring procedures, monitoring well construction details, sampling techniques, aquifer testing and data analysis methodologies.
- The Site Specific Health and Safety Plan provides the field personnel with a description of procedures and personal protective equipment to be used for while conducting the field investigation.

Each of the documents has been developed in conformance with the appropriate U.S. EPA guidance documents.

This Work Plan describes the activities proposed for the performance of the Remedial Investigation (RI) and Feasibility Study (FS) at the Woodstock Municipal Landfill in the Town of Woodstock, Illinois. The Work Plan was prepared in accordance with the Administrative Order by Consent (AOC), effective October 14, 1989, between the U.S. Environmental Protection Agency (U.S. EPA) and a group of potentially responsible parties (PRPs). A Statement of Work (SOW) dated August 30, 1989 was a part of that consent agreement and it established a conceptual framework for conducting the RI/FS. Warzyn Engineering Inc. (Warzyn) was retained on behalf of the Respondents, to prepare the RI/FS Work Plan.

The Woodstock Municipal Landfill Site (Woodstock Site) is located near the southern boundary of the City of Woodstock, Illinois, a small municipality with a population of approximately 12,500 residents. The site is located south of Davis Road, southwest of the intersection of U.S. Route 14 and Illinois Route 47 (Figure 1). A wastewater treatment plant operated by the City of Woodstock is located south of the site; and Kishwaukee Creek flows near the southwest border of the landfill.

The site had a number of different owners between 1935 when it was first used as a trash dump and open burning area, and October 1, 1980, when it was classified as closed and covered by the Illinois Environmental Protection Agency (IEPA). A U.S. EPA study of aerial photographs indicates that site operation began in the southwest corner of the site and moved outward to the east and north. The total potentially filled area consists of about 40 acres. The site has been owned by the City of Woodstock since 1968, when it was conveyed to the city by means of a Warranty Deed. Following closure, the City of Woodstock was granted a permit from IEPA to landfarm municipal sewage sludge at the site.

The hydrogeology of the Woodstock landfill and four other Illinois landfills was investigated by the Illinois State Geologic Survey (ISGS), under a Solid Waste demonstration grant from the U.S. government. The results of the investigation were reported in 1971 in a U.S. EPA publication, Hydrogeology of Solid Waste Disposal Sites in Northeastern Illinois. The pages and data summaries which reference the Woodstock Landfill are included in Appendix A of this Work Plan.

In March 1985, the U.S. EPA conducted a site investigation to evaluate the site by the Hazardous Ranking System (HRS) for inclusion on the National Priorities List (NPL). The factors which caused the listing were: (1) the reported burial of hazardous substances at the site and (2) the existence of a city well within 1.5 miles of the site. Although this potential source has been identified and potential receptors are present, no pathways between the two have been documented.

This Work Plan addresses items needed to fulfill the requirements for an RI/FS. The RI/FS Work Plan recognizes the interdependency of the RI and FS. The objective of the RI is to determine the nature and extent of the contamination at the site in order to support the activities of the FS. The objective of the FS is to develop and evaluate appropriate remedial action alternatives based on RI data. Personnel, materials and services required to perform the RI/FS will be provided by the Respondents to the AOC. A schedule for implementation of RI/FS tasks and submission of RI/FS reports and deliverables is contained in Table 1.

SECTION 2

SITE BACKGROUND AND SETTING

LOCATION AND USE

The Woodstock Municipal Landfill Site (Woodstock Site) is located on the south side of the city of Woodstock, Illinois, a small municipality with a population of approximately 12,500 residents. The site is located south of Davis Road, southwest of the intersection of U.S. Route 14 and Illinois Route 47 (Figure 1). The civil rectangular coordinates for the site are northeast quarter of Section 17, Township 44 North, Range 7 East (NE 1/4, Sec 17, T44N, R7E).

The land surrounding the Woodstock site is a mixture of residential, agricultural, commercial and light industrial use. Land use immediately north of the site is primarily residential and agricultural. Land use west of the site is semi-agricultural with much of the land currently undeveloped. Land use east of the site is primarily commercial and light industrial with some areas remaining undeveloped. Kishwaukee Creek, confined in a drainage ditch, runs south along the southwestern perimeter of the site. The City of Woodstock wastewater treatment plant is located south of the site, between the landfill boundary and the creek.

There are residential wells located to the north, west, south and east of the site. City of Woodstock municipal wells are located north of the site. One well is located approximately 1.5 miles from the site and four (4) additional wells are located within 3 miles from the site. Well logs have been obtained from the Illinois State Water Survey (ISWS) for the nine sections including and surrounding the landfill (Sections 7, 8, 9, 16, 17, 18, 19, 20, and 21). The location, owners and depths of the 43 water supply wells located closest to the site are summarized on Table 2. Well locations are shown on Figure 2.

SITE HISTORY

Site Ownership

The site had a number of different owners between 1935 when it was first used as a trash dump and open burning area and when it was covered and classified as closed by the Illinois Environmental Protection Agency (IEPA) on October 1980. The current owner of the landfill property is the City of Woodstock. The history of ownership of the landfill property is as follows:

On May 31, 1940, Harry and Eunice Davison conveyed the site property to William E. Gaulke by means of a Warranty Deed.

On April 10, 1945, William E. Gaulke and his wife granted six parcels of land including the site property to the Woodstock Commission Sales Company for highway purposes, by means of a Warranty Deed.

On March 30, 1956, the Woodstock Commission Sales Company, Inc. conveyed six parcels of land, including the site property, to William E. Gaulke by means of a Warranty Deed.

On August 1, 1958, William E. Gaulke leased the site property to the City of Woodstock. The lease was for a period of five years. The lease agreement was subsequently extended for another five years in 1963.

On September 6, 1968, William and Dorothy Gaulke conveyed the site property to the City of Woodstock by means of a Warranty Deed.

Operational History

From approximately 1935 until leased to the City of Woodstock in 1958, the site was used as a local trash dump and open burning area by unknown persons or companies. The site was used by the City under a lease agreement as a household garbage and municipal landfill from 1958, until its acquisition by the City in 1968. Following acquisition of the property by the City, the property was used for the disposal of household and municipal solid waste and various industrial solid wastes. The City of Woodstock discontinued disposal activities at the site in 1975, and the landfill was classified as closed by the IEPA in October 1980. In 1983, the City was granted a permit from IEPA to landfarm municipal sewage sludge at the site. A second permit was issued by IEPA in July 1988, but sludge application was discontinued prior to that date, so the permit has not been used.

DESCRIPTION OF DISPOSAL ACTIVITIES

Prior to its use as a municipal landfill, the Woodstock site was undeveloped. During the early period of landfilling and open burning (1935 to 1958), the operation of the site was confined primarily to its western portion. Between 1954 and 1964, landfilling operations expanded eastward to the center of the site and disposal of lime slurry from the City of Woodstock water treatment plant began sometime during this period. According to the aerial photographs of the site taken January 28, 1964, the original areas of landfilling noted in 1954 had been revegetated. In 1964, the easternmost portion of the site was used for agricultural purposes.

Between the period of January 1964 and October 1967, landfilling operations were expanded to encompass the entire western half of the landfill. The agricultural land located in the eastern portion of the landfill was separated from the landfilling operations by approximately 1500 ft of undeveloped land. Between the period from October 1967 until March 1970, landfilling operations continued to expand in the southern portions of the landfill site and had encompassed the former agricultural area in the eastern portion of the site. It is documented that random excavation operations began during this period in the eastern portions of the landfill and continued until 1975 when the landfill was closed permanently.

Between March 1970 and October 1972, filling operations continued over the entire landfill area. Expansion of the landfill occurred in the southeastern portion of the site. Electroplating sludges were also reported to have been disposed with municipal waste during this period. The southwestern border of the site, running along Kishwaukee Creek was the only remaining undeveloped land.

Between October 1972 and October 1974, landfilling operations continued over the majority of the site. Areas previously covered began to receive additional waste materials. Aerial photographs taken October 10, 1974, show apparent lime slurry disposed (as noted in previous photographs) to the southwestern portion of the landfill.

Between October 1974 and March 1976, the majority of the landfill surface was covered and landfilling operations were ceased. No further waste was received at the landfill after 1980. Between March 1976 and October 1980, the majority of the landfill cover was revegetated. Grading and filling occurred in the central and eastern portions of the landfill. The lime slurry area in the southwestern portion of the site was still evident according to aerial photography taken October 21, 1980. Currently, the landfill site is completely covered, and mostly vegetated.

In July 1989, U.S. EPA performed an analysis of aerial photographs from the years 1954, 1964, 1967, 1970, 1972, 1974, 1976, and 1980 to reconstruct the historical development of the Woodstock Landfill. The resulting publication, Site Analysis-Woodstock Municipal

Landfill, TS-PIC-89030, was completed under contract number 68-03-3532. In Figure 3 of the document, an aerial photograph taken January 28, 1964, the U.S. EPA identifies a zone of "possible containers". A copy of the aerial photograph with U.S. EPA notations is included as Figure 3 of this report. In Figure 7 of the U.S. EPA report, an area north of the site was identified as being filled.

PREVIOUS INVESTIGATIONS

On June 17, 1970, representatives of the McHenry County Health Department reported a possibility that leachate from the landfill site was causing color changes in water in Kishwaukee Creek. The investigation was prompted by a citizen complaint concerning the color and odor of the creek downstream of the landfill site. During the inspection, the water was reported to be black in color and to have a septic odor. The Health Department investigation located a leachate seep discharging black odiferous liquid into the creek at the southwestern portion of the landfill. U.S. EPA has reported that pursuant to the Health Department inspections and public complaints, the IEPA filed a formal complaint against the City of Woodstock on April 18, 1972. The complaints cited the following charges against the City:

- Failure to obtain the necessary permits for the disposal of solid wastes;
- Open dumping of garbage and refuse without application of daily cover; and
- Illegal disposal of liquids.

The alleged illegal liquid disposal was later found to be lime slurries which had been recommended for application by IEPA. The proceedings resulted in the City's application for a solid waste disposal permit. The City applied for and received a solid waste permit to operate the landfill with conditions. The permit conditions required the City to install a groundwater monitoring system and a leachate collection system. No leachate collection system or groundwater monitoring system have been installed at the landfill.

In 1971, the Illinois State Geological Survey (ISGS) completed a report titled Hydrogeology of Solid Waste Disposal Sites in Northeastern Illinois. In the paper, the ISGS identified various landfills in the area and discussed the site-specific geological and hydrogeological conditions existing at the Woodstock site. Copies of the pages referring to the Woodstock site are included in Appendix A of this document.

On January 28, 1974, the City of Woodstock applied for a modification to their operating permit to allow them to accept electroplating sludges. The actual approval or denial of this permit modification was never resolved. Electroplating sludge disposal was discontinued in 1975.

The site was classified as closed and covered by IEPA in 1980.

In May 1983, the IEPA granted the City a permit to apply municipal sewage sludge to the landfill surface. Another permit was issued in July 1988 for the land application of municipal sewage sludges, but the permit was not used because application of sludges had been discontinued earlier in 1988. Figure 4 indicates the areas on which sewage sludge was spread prior to 1980.

In March of 1985, U.S.EPA conducted a Site Investigation at the landfill site for the purposes of scoring the site for possible inclusion on U.S.EPA's NPL.

In June and December 1988, residential well sampling was conducted by U.S.EPA. An aerial photography assessment was conducted by U.S.EPA in 1989.

SECTION 3 INITIAL EVALUATION

PRELIMINARY DATA GATHERING (Task 1, SOW)

Residential Well Survey (Subtask 1A, SOW)

There are residential wells located to the north, west, south and east of the site. Well logs have been obtained from the Illinois State Water Survey for Section 17 (the section containing the landfill), and the surrounding sections (7, 8, 9, 16, 18, 19, 20, and 21). Table 2 lists the name of the owner, the reported depth, the distance and direction from the landfill of the 43 water supply wells located closest to the site. Well locations are shown on Figure 2. If additional wells are identified during the investigation, they will be added to the map and table. The decision tree presented in Table 3 will be used in conjunction with the water supply well information and other investigative data to determine which, if any, of the residential wells will be sampled and also to designate the appropriate parameters for analysis.

Survey and Mapping of the Site (Subtask 1B, SOW)

Although the SOW suggested developing a site base map with a contour interval of 1 ft and a scale of 1 inch equal to 50 ft, it was agreed with the U.S. EPA Remedial Project Manager, (RPM), that a recently developed site topographic map will be sufficient for the remedial investigation. The existing base map has a contour interval of 2 ft and a scale of 1 inch equal to 100 ft. The base map will be used during the RI/FS to show the following:

- the general geographic location;
- property lines of adjacent ownership,;
- topography and surface drainage patterns;
- structures, utilities, paved areas, easements, rights-of-way, roadways, and other features;
- surrounding land uses (residential, commercial, agricultural, recreational; and,
- locations of sampling points on the site, including landfill borings, soil borings, and monitoring wells.

A 100-ft surveyed grid has been established at the site with orange 1 x 2 in, 4 ft surveyor's stakes. A stake is placed every 100 ft on the site, starting with arbitrarily assigned coordinate (0,0) at the northwest corner of the site. The north-south lines were oriented to magnetic north to facilitate use with a compass. The grid marked on the site basemap in Drawing 1. The grid map also shows the preliminary locations of monitoring wells and several other sampling points. These locations may be adjusted as more is learned during the field investigation.

DESCRIPTION OF CURRENT SITUATION (Task 2, SOW)

Types and Volumes of Waste

Little is known as to the identities and quantities of waste materials disposed at the site. The materials reported to have been disposed of at the site include municipal waste, lime slurry, and electroplating sludges containing primarily nickel, copper, cyanide and chromium. Other potentially hazardous substances are reported to have been disposed at the landfill including some combustible wastes.

Records, Observations, and Sampling, in the Site Vicinity

Groundwater

The potable water supply for the area is provided by both the public water system and private wells. Residents living along the U.S Route 14, and those living southwest of the site along Dean Street obtain their water from either city water or private wells. The City of Woodstock draws its water from five wells screened in sand and gravel deposits within the glacial drift. One well is located within 1.5 miles of the facility, and four wells are located approximately 3 miles from the facility. Locations of the water supply wells closest to the site in each direction are shown on Figure 2; details are summarized in Table 2.

On March 14, 1989 the Woodstock municipal wells were sampled for volatile organic compounds (VOC). None were detected. In July of 1988, U.S.EPA's Technical Assistance Team (TAT) collected water samples from several residential wells near the Woodstock Municipal Landfill site. Concentrations above the Safe Drinking Water Act MCLs for arsenic, selenium and thallium were indicated in several of the samples. However, when the wells were re-sampled by TAT in December 1988, concentrations of these metals were below MCLs.

Surface Water

The only surface water sampling data available from Kishwaukee Creek is obtained by the City of Woodstock pursuant to their discharge permit for the wastewater treatment plant.

Soil/Sediment

Data obtained from the U.S. EPA Field Investigation Team's survey of the site in 1985, indicated the presence of some metals in soils at concentrations which exceed the probable background concentration ranges. These include arsenic, barium, cadmium, chromium, lead, silver, and zinc. The presence of 1,1,1-trichloroethane was also reported.

Potential Pathways

Potential migration pathways from the Woodstock Site include groundwater, surface water, sediment and air. Groundwater and surface water have been identified as the potential pathways of concern, between potential sources and receptors. The field work conducted at the site will include data collection to provide a delineation of the potential migration pathways by surface water (hydrological) and by groundwater (hydrogeology). Sampling will also be conducted on sediment, soils, and air to document the potential of other migration pathways.

Hydrology

Surface water features near the site include Kishwaukee Creek to the south, an excavation filled with water north of the site across Davis Road, a small adjoining marsh area, just east of the boundary along the northern portion of the landfill, and an inundated, marshy area between the south boundary of the landfill and Kishwaukee Creek. The RI will investigate the potential for hazardous substances in the surface water and/or sediment following the sequence in the surface water and sediment sampling decision tree (Table 4).

Releases of leachate to the main surface water body in the area, Kishwaukee Creek, were documented in an inspection report dated June 17, 1970, by representatives of the McHenry County Health Department. The report documented that leachate from the landfill was responsible for discoloration of the water and a strong septic odor. A clay cover was subsequently applied to the landfill. Following the placement of the clay cover, the City of Woodstock applied municipal wastewater sludges to portions of the covered landfill as part of landfarming operations in accordance with a permit issued by IEPA.

Hydrogeology

According to the Illinois State Geological Survey report, Hydrogeology of Solid Waste Disposal Sites in Northeastern Illinois (Appendix A, 1971), the surface soils surrounding the Woodstock site are primarily composited of silty sandy clays which range in thickness between 1 and 4 feet. Peat and non-organic silts (5 to 19 ft thick) probably make up the majority of the soils in marshy areas around and below most of the southern two-thirds of the site. Underlying the peat soils is a sand and gravel unit which may or may not be continuous throughout the site. Therefore, there may be surficial sand and gravel aquifer beneath the northern part of the landfill and it may extend southward beneath the landfill.

Two till units are identified between ground surface and the bedrock, at a depth of about 225 feet. The thickness of the upper till ranges in thickness between 3 and 25 feet. It is composed primarily of a silty clay. The Woodstock water supply wells are completed in a thick sand and gravel aquifer contained in the lower till unit. However, well logs for wells located south of the site, and the boring logs in the ISGS report, indicate that the lower till beneath the landfill site is composed primarily of a series of silty sandy clay tills which extend to bedrock. It is apparent that the sand and gravel aquifer pinches out somewhere north of the landfill, and there is no aquifer beneath the site in the more than 225 feet of unconsolidated materials overlying the bedrock. The bedrock consists of shales and dolomites of the Maquoketa group.

INTERIM MEASURES EVALUATION (Task 3, SOW)

The following summarize the basis for current understanding of the site conditions.

- In 1971, the Illinois State Geological Survey (ISGS) published the Hydrogeology of Solid Waste Disposal Sites in Northeastern Illinois (Appendix A includes relevant pages and tables). The Woodstock site was one of five landfills included in the investigation. For the study, soil borings were made to collect and analyze soil samples and for placement of monitoring wells. The results of groundwater sampling at the two downgradient monitoring wells, LW3 and LW5, showed "no evidence of downward movement through the clay". The ISGS interpreted these results to indicate that, at least at that time, the landfill had not had an impact on the groundwater downgradient from the site.
- The U.S. EPA TAT sampled private wells in the vicinity of the landfill on two occasions in 1988. Although there was some ambiguity in the results, the results did not indicate that the landfill has contaminated the groundwater.
- Quarterly sampling of Woodstock municipal wells for Primary Safe Drinking Water constituents and VOCs has been conducted since 1986. Concentrations of all parameters have been below MCLs, or have not been detected, for all sampling events.
- Representatives of U.S. EPA, IEPA, Versar, and Warzyn conducted a site walk-through on November 9, 1989. Although some evidence of minor leachate seepage was noted, there was no evidence of on-going significant environmental impacts at the site.

On the basis of this information and the Hazard Ranking Score (HRS), it appears that the Woodstock Site does not present an imminent endangerment to human health or the environment. However, it is recognized that new information will be developed as the investigation progresses. Therefore, the need for interim measures will be re-evaluated and addressed as necessary in monthly status reports and/or technical memoranda, as the investigation proceeds. The U.S. EPA RPM will be involved in the decision process. Since the site is classified as an NPL site, locking gates and fences at the site have been repaired, and access to the site has been restricted to only those involved in the investigation.

PRELIMINARY REMEDIAL ACTION ALTERNATIVES (Task 4. SOW)

The purpose of the Feasibility Study is to identify and evaluate alternatives for the appropriate extent of remedial action, if any, to achieve or comply with applicable or relevant or appropriate requirements, standards, limitations, criteria or goals and/or to prevent or mitigate the migration or the release or threatened release of hazardous substances, pollutants or contaminants from the Woodstock Site.

The data collected in the RI will be the primary source of information used to evaluate and select the appropriate remedy. Therefore, it is appropriate to develop a preliminary list of potential remedial actions early in the RI/FS process to assure the collection of the data appropriate to evaluate their potential effectiveness. As the RI/FS progresses, and a better understanding of the site is gained, the list of potential alternatives or combinations of alternatives will be refined.

On the basis of a review of the existing information and a site inspection, a preliminary list of remedial action alternatives has been developed:

1. No-Action. Each RI/FS must include evaluation of the no-action alternative for completing the endangerment assessment. Implementation of the No-action alternative would require some sampling and analysis.
2. Limited Action. A limited action alternative will be evaluated which recognizes that no active remedy will be necessary, but that a limitation of site access may be appropriate. For example, fencing, deed restriction, or providing alternate source of water supply.
3. Capping. Selected areas of the landfill could be capped and/or re-vegetated to reduce the generation of leachate.
4. Grading, Berms, Dikes, Seepage Basins. Potential migration of contaminants and sediment could be minimized by the construction of one or more of these structures to control surface water runoff and runoff.

These structures may also be evaluated for potential in limiting surface water contamination, by limiting discharge of contaminants to Kishwaukee Creek or other surface water bodies.

5. Cut-Off Walls. A slurry wall, sheet piling, or grout injection could be placed as a barrier to the flow of groundwater.
6. Groundwater Pumping. Groundwater pumping could be used to remove groundwater for treatment and/or to impose a hydraulic barrier in an aquifer to control groundwater flow, or limit groundwater discharge to Kishwaukee Creek or other surface water bodies.
7. Gas Extraction. If landfill gas is found to represent a potential endangerment, it may need to be extracted by pumping.
8. Leachate Extraction. As a potential source of contamination, it may be necessary to reduce the hydraulic head and/or the volume of leachate by pumping.

9. Biological Treatment. Bioremediation may be an appropriate method to reduce the contamination of sediments or groundwater in the site vicinity.
10. Chemical Treatment. It may be appropriate to use chemical methods such as ultra-violet radiation, or oxygenation by application of hydrogen peroxide to reduce contamination of sediments or groundwater.
11. Physical Treatment. Air stripping of groundwater may be appropriate to reduce contamination of groundwater.
12. Discharge to Surface Water or POTW. If groundwater is pumped from the site vicinity, the extracted (and treated) groundwater must be released. The most probable release points would be to surface water or to the local POTW.

Identification of Data Needs

A preliminary identification data needs to complete the RI/FS for the Woodstock Site has been developed and is summarized in Table 5.

SECTION 4

PLANS AND MANAGEMENT

The planning documents for the RI/FS at the Woodstock Site consist of a Work Plan (WP), a Field Sampling Plan (FSP), a Quality Assurance Project Plan (QAPP), and a site specific Health and Safety Plan (HSP) (Task 5, SOW). Each of the plans has a specific purpose, and efforts have been made to avoid duplication of focus in the documents.

For example, although monitoring well installation will be discussed in all four of the documents, each document addresses a different aspect of the process. The focus of monitoring well activities in the Work Plan will be to specify the number and locations of wells and describe the rationale for each of the well locations. The focus of the FSP is to describe the details of soil boring and sampling, well construction, groundwater sampling procedure, and aquifer testing. The QAPP contains the specific protocols which will be followed for sampling, sample handling and storage, chain-of-custody, and laboratory (or field) analysis. The Site Specific HSP provides the field personnel with a description of procedures and personal protective equipment to be used for while making soil borings, constructing monitoring wells and collecting samples.

A detailed description of each of the planning documents follows.

WORK PLAN (WP)

This RI/FS Work Plan has been developed in conformance with the provisions of the Consent Order and standards set forth in the following statutes, regulations and guidance:

- Section 121 of CERCLA;
- U.S. EPA "Guidance for Remedial Investigations and Feasibility Studies Under CERCLA", Interim Final, EPA/540/G-89/004, OSWER Directive 9355.3-01, dated October 1988;
- National Contingency Plan (NCP), dated November, 1985, as amended; and
- Additional Guidance Documents provided by U.S. EPA.

The purpose of the work plan is to define the scope and objectives of the RI/FS. The scope consists of proposed numbers and locations for each of the field activities and details for completion of non-field activities. Recognizing that some modification in the number of samples, sampling locations and parameters may be appropriate as more is learned about the site, the objectives for each activity are also provided to aid decision making.

The schedule, included as Table 1, shows the implementation of tasks and submission of deliverables in weeks subsequent to regulatory approval. It does not include extended U.S. EPA review periods.

FIELD SAMPLING PLAN (FSP)

A Field Sampling Plan (FSP) addressing data acquisition activities for the RI has been prepared. The plan contains a summary of the site background, a statement of sampling objectives, a listing of sample locations and frequency, sample designation, sampling equipment and procedures, and a summary of sample handling and analysis. The procedures described in the FSP include methods for source characterization and preliminary migration pathway assessment including soil borings, well installations, determination of groundwater levels, hydraulic conductivity tests, and surface water, soil, sediment and groundwater sampling.

QUALITY ASSURANCE PROJECT PLAN (QAPP)

A Quality Assurance Project Plan (QAPP) has been prepared in accordance with current U.S. EPA guidance. The QAPP specifies the analytical methods and protocols to be used at the various stages of the site investigation. Specific methods are defined for field screening of samples, waste and contaminant characterizations and bench and pilot treatability testing. U.S. EPA Contract Laboratory Program (CLP) protocols will be used for waste and contaminant characterization analyses. The proposed outline for the QAPP will include:

Title Page

Table of Contents

- 1. Project Description**
- 2. Project Organization and Responsibility**
- 3. Quality Assurance Objectives**

4. Sampling Procedures
5. Sample Custody
6. Calibration Procedures and Frequency
7. Analytical Procedures
8. Internal Quality Control Check
9. Data Reduction, Validation, and Reporting
10. Performance and Systems Audits
11. Preventative Maintenance
12. Specific Routine Procedures used to Assess Data Precision, Accuracy and Completeness
13. Corrective Actions
14. Quality Assurance Reports to Management

This list is at slight various from the list in the SOW, but it conforms to EPA Guidance for Conducting RI/FS under CERCLA.

SITE SPECIFIC HEALTH AND SAFETY PLAN (HSP)

The Health and Safety Plan has been prepared to address hazards that the investigation activities may present to the investigation team and to the surrounding community. The plan conforms to applicable regulatory requirements and guidance including:

- "Occupational Safety and Health Standards for Hazardous Waste Operations and Emergency Response" [29 CFR 1910.120 (I)(2)], Interim Rule, December 19, 1986;
- U.S. EPA Order 1440.3 - "Respiratory Protection";
- U.S. EPA Order 1440.2 - "Health and Safety Requirements for Employees Engaged in Field Activities";
- U.S. EPA Occupational Health and Safety Manual; and
- U.S. EPA Standard Operating Safety Guides (November 1984).

The Health and Safety Plan details personnel responsibilities, protective equipment, procedures and protocols, decontamination, training and medical surveillance. The plan identifies problems or hazards that may be encountered and their anticipated solutions. Procedures for protecting third parties such as visitors or the surrounding community are also provided.

ATSDR HEALTH ASSESSMENT

Copies of the Planning Documents and information collected during the RI/FS will be made available by the U.S. EPA to the Agency for Toxic Substances and Disease Registry (ATSDR) pursuant to SARA.

SECTION 5

REMEDIAL INVESTIGATION TASKS

Section X.A. of the Administrative Order By Consent (AOC) states that the draft Remedial Investigation Report shall be due within 365 calendar days of receipt of U.S. EPA's approval of the RI/FS Work Plan. The Statement of Work in the AOC organizes the Remedial Investigation into ten tasks for characterizing the Woodstock Site.

- TASK 1 Preliminary Data Gathering
- TASK 2 Description of the Current Situation
- TASK 3 Interim Measures Evaluation
- TASK 4 Pre-Investigation Evaluation of Remedial Alternatives
- TASK 5 RI/FS Work Plan Requirements and Preparation
- TASK 6 Site Investigation
- TASK 7 Site Investigation Analysis
- TASK 8 Laboratory and Bench-Scale Studies
- TASK 9 Community Relations
- TASK 10 RI Report

The first five tasks have been completed during the development of the project planning documents and the results have been incorporated into the planning documents, including this Work Plan. Descriptions of Tasks 6 through 10 are presented in the following sections.

This Remedial Investigation has been organized to follow a phased approach to investigation as recommended in the Superfund Amendments and Reauthorization Act of 1986 (SARA). The 365 day schedule for completion of the RI has been organized into three phases, tentatively scheduled for completion between June 1990 and July 1991.

Following a phased investigation allows the optimal use of current information and minimizes the occurrences of data overlaps and data gaps. The phased approach allows "mid-course" corrections to be made so that the investigation will develop in the most efficient and cost-effective sequence. Two phases of investigation have been developed in detail to make optimal use of site information as it is derived to produce the information which is necessary to complete the Endangerment Assessment (EA) and the F.S. A specific scope of work for a third phase of investigation would be developed if and when it is determined from data collected in previous phases that additional information will be necessary to complete the objectives of the RI/FS.

Phase I tasks will include:

Preliminary Site Evaluation

Source Characterization

- Geophysical surveys
- Methane gas screening
- Test borings in landfill at 5 locations
- Leachate head wells/gas vents constructed at 5 locations in the landfill
- Collect landfill gas samples at 2 landfill head well/vent locations
- Collect and analyze leachate samples at each of the landfill head wells where it is found to exist

Migration Pathway Assessment

- Install surface water reference elevation markers (staff gages)
- Soil borings outside the landfill at 6 locations
- Complete 2-well monitoring nests at each of 6 locations surrounding the landfill
- Survey elevations at leachate wells and monitoring wells, collect water levels, and determine groundwater flow directions beneath landfill
- Collect round 1 groundwater samples
- Collect soil/sediment samples at eight locations surrounding the landfill
- Collect surface water/leachate sample at 1 location south of the landfill, adjacent to Kishwaukee Creek
- Collect water levels at monitoring wells, head wells, and staff gages

Phase II Tasks - Phase II tasks may be modified on the basis of Phase I finding; currently they are projected to include the following:

- Collect water levels at monitoring wells, head wells, and staff gages
- Collect round 2 leachate samples
- Collect round 2 groundwater samples at Phase I monitoring wells
- Conduct field screening to aid in identifying the extent of potential contaminant plumes in the groundwater in order to optimize location and numbers of monitoring wells
- Construct additional monitoring wells
- Collect round 1 groundwater samples at Phase II monitoring wells
- Collect additional soil/sediment samples at a currently anticipated four additional locations if Phase I results indicate the data is needed to meet the objectives of the RI/FS
- Collect additional surface water samples if Phase I results indicate the data is needed to meet the objectives of the RI/FS
- Collect round 2 groundwater samples at Phase II monitoring wells

Phase III tasks:

- If data from previous phases indicate that additional information is needed to adequately characterize the horizontal and vertical extent in any contaminated media, additional field work may be required. Additional work could include the collection of aquifer matrix samples or the installation of additional monitoring wells.

TASK 6 - SITE INVESTIGATION

A schedule has been developed to show the sequencing of site construction and sampling which will be used to complete three phases of the remedial investigation in the allotted 365 days (Figure 5). Task 6, the Site Investigation is subdivided into 8 subtasks.

- 6A Methane Gas Survey
- 6B Geophysical Surveys
- 6C Hydrogeologic Investigation
- 6D Landfill Characterization

6E	Soils/Drainage-Way Sampling
6F	Surface Water/Sediment Investigation
6G	Air Investigation
6H	Wetland Delineation

In Phase I, work will be performed in each of the subtasks in Task 6. Some of the subtasks will be completed in Phase I, while others will be continued into later phases. To facilitate discussion of the multi-phased investigation, each of the individual subtasks will be discussed below with indications of the potential for second and additional phases of work.

The field work for each phase of the RI will begin with a "staking visit", attended by representatives of the respondents, U.S. EPA, and IEPA. The purpose will be to make final determinations as to the location of each sample to be collected during the phase, in order to adequately meet the objectives of the RI/FS.

SUBTASK 6A - METHANE GAS SURVEY

The primary concern regarding methane gas is its explosivity. The purpose of gas sampling will be to evaluate the potential for landfill gas methane to migrate from the landfill to locations (e.g., basements) in which it could accumulate to an explosive concentration. Therefore, the evaluation of methane levels will be conducted with a "Gas-Tech" or similar instrument which quantifies the percentage of hydrocarbon gas in the air.

Three methods will be used to survey and evaluate methane production and gas concentrations:

- During the field investigation phase, ambient levels of methane will be monitored and recorded;
- When leachate head wells and monitoring wells are sampled, the analytical instrument will be used to measure the gas concentration emanating from each monitoring well/leachate head well; and
- If there is gas pressure noted at the leachate head wells, the gas survey will be extended to include the adjacent perimeter of the site where soil borings show that there is a sufficiently thick vadose zone to allow the migration of gas away from the landfill. The method used will be to drive a probe into the ground, collect pressured gas in a bag, then measure for percentage of gas content.

During field investigation activities a visual survey of stressed vegetation will be done to identify any isolated potential landfill gas migration pathways. In addition, existing maps and records will be used to identify and locate engineered structures which could act as migration pathways for landfill gas away from the landfill. Such structures could include buried sewer and utility lines.

SUBTASK 6B - GEOPHYSICAL SURVEY

Geophysical methods will be used for two purposes in the initial stages of the investigation: 1) to attempt to identify possible leachate seeps and groundwater contamination and 2) to map anomalies in a landfill area where U.S. EPA suspects containerized waste may have been disposed.

Leachate characteristically exhibits high conductivity because of its high level of total dissolved solids. As a consequence, leachate seeps and groundwater which is highly contaminated with leachate may appear as anomalies in soil conductivity surveys. A soil conductivity survey will be conducted adjacent to the landfill to gather information concerning the potential extent of groundwater contamination and the location of possible leachate seeps from the landfill. The survey will be conducted using electromagnetic (EM) methods with an EM-31D Terrain Conductivity Meter.

It is recognized that the resulting data may be of limited utility because of other naturally occurring conductivity anomalies. For example: 1) clay lenses located within sand aquifers and 2) bermed areas which represent areas of spatially variable mass can appear as anomalies in geophysical surveys. However, the geophysical data will be useful in conjunction with other investigative data including boring information and observation of surficial conditions.

To delineate the extent of filled area, geophysical investigation will be conducted by electromagnetic (EM) survey. Side berms are evident along the west boundary, the southwest corner, and the northern half of the east boundary so geophysical survey will not be necessary to delineate filled zones there. At the other boundaries, including the northern boundary and the southeast corner, there is no topographic indication of the extent of fill. These are the areas in which geophysical surveys may be useful to delineate areas of past filling.

In July 1989, U.S. EPA performed an analysis of aerial photographs from the years 1954, 1964, 1967, 1970, 1972, 1974, 1976, and 1980 to reconstruct the historical development of the Woodstock Landfill. The resulting publication, Site Analysis-Woodstock Municipal Landfill, TS-PIC-89030, was completed under contract number 68-03-3532. In Figure 3 of the document, an aerial photograph taken January 28, 1964, the U.S. EPA identifies a zone of "possible containers". A copy of the aerial photograph with U.S. EPA notations is included as Figure 3 of this report. An EM geophysical survey will be conducted across the area of suspected container burial. A geophysical grid will be layed out in a rectangle to coincide with the suspected container area; the grid will be extended approximately 50 feet further in each direction than indicated on the aerial photograph (the approximate area is plotted on Figure 6). If a major anomaly is identified, it will be mapped, even if it extends beyond the originally gridded area. The initial geophysical grid will be layed out within the following base map coordinates: Upper left corner = 800S, 200E, Lower right corner = 1050N, 500E. The area is marked on Drawing 1.

Prior to making instrument readings, a matrix of flags with 50-foot spacing will be arrayed across the possible container burial area. The geophysical survey will be conducted on a 25-foot grid, guided by the marked 50-foot grid. Traverses will be made along each guideline as well as along a line midway between each set of gridlines, making an instrument reading each 25 ft. interval.

The geophysical surveys will be performed over a five day period prior to the initiation of intrusive field activities so that the results may be used in selecting locations for monitoring wells and surface water sampling sites. The first day of survey will be used to calibrate the instrument, establish areas which will yield usable data for interpretation, and lay out survey grids. The following days will be used to complete surveys in the areas identified as conductive to EM survey.

Geophysical surveys will be performed in these areas by From Applied Technology, with oversight provided by Warzyn.

SUBTASK 6C - HYDROGEOLOGIC INVESTIGATION

The purpose of the hydrogeologic investigation will be to further characterize the subsurface geology, water bearing formations and groundwater quality. It will begin with a survey and evaluation of previous hydrogeologic studies and previously generated site

and regional data. Then the required phases of the field investigation will develop the data to characterize the site geology and groundwater flow system.

Geologic Characterization.

A Warzyn geologist will develop borings logs for each of the monitoring wells, leachate wells, and all borings drilled during the investigation (whether or not a well is installed at the location). Twelve monitoring wells will be constructed at 6 locations during the Phase I investigation and a currently estimated additional 10 monitoring wells will be installed in Phase II. Additional monitoring wells could be required in additional phases of investigation if the data from previous phases is insufficient to meet the objectives of the RI/FS.

At six of the locations outside the landfill, the borings will be extended to a depth of at least 50 feet to document the geologic stratigraphy in the vicinity of the landfill. Where possible, soil sampling will be conducted continuously using a split-spoon sampler which precedes the lead auger, collecting an uninterrupted sample for each five foot advance of the augers. If there are numerous pebbles or cobbles in the soil, continuous sampling by this method may not be possible, in which case, soil sampling will be conducted on 2.5-foot intervals following ASTM D1536 methods. The six borings will be arrayed to provide both a north-south cross-section and an east-west cross section, with at least three borings each.

Previous studies have indicated that the general geologic sequence beneath the site in the upper 50 feet consists of a shallow sand and gravel aquifer beneath the surface, underlain by 50 to 100 feet of glacial till, with lenses of sand and gravel, perhaps interlayered between the till units. It is anticipated that in each of the six Phase I well nests, the shallow well will be screened in the upper sand and gravel zone and the deeper well will be screened in a lower sand and gravel lens. Field decisions may be necessary to select the final screening zone, with concurrence of the U.S EPA RPM.

To aid in developing the geologic characterization of the site, nine soil samples will be collected and analyzed for parameters including grain size, cation exchange capacity, total porosity, and total organic carbon. In each of three borings, three samples will be collected: one sample will be collected of the upper sand and gravel, one sample will be collected to represent the lower sand and gravel lens, and a third will be collected by

shelby tube, of the clay till separating the two sand and gravel zones. A section of the three samples collected by Shelby tube will be laboratory analyzed for vertical permeability by the tri-axial method.

To further aid in developing the site stratigraphy, photographs may be taken of undisturbed split spoon samples which exhibit significant stratigraphic sequences or structural details (i.e. sand/gravel layers in a clay horizon, clay fracture zones, or zones discolored by contamination).

Groundwater Flow Characterization

The landfill is located in a lowland area, adjacent to the Kishwaukee Creek. From published information (Appendix A), it is apparent that the landfill is underlain by several hundred feet of glacial deposits. Some distance north of the site, there appears to be a sand and gravel aquifer contained within the glacial sequences, 60 to 100 feet below ground surface. The aquifer apparently has not been found in wells drilled south of the site. To characterize the groundwater flow regime in this hydrogeologic setting and determine the potential groundwater migration pathways, it will be important to document both vertical and horizontal gradients.

Specific field activities are planned for two phases of the investigation to complete the hydrogeologic characterization. The activities planned for Phase I include: the placement of staff gages to document surface water levels; the construction and sampling of 5 leachate head wells in the landfill; the construction and sampling of 6 2-well monitoring well nests surrounding the landfill (for a total of 12 monitoring wells). The locations are shown on Figure 7. The locations of the Phase I monitoring wells have been selected to surround the landfill, thereby providing an indication of the groundwater quality on all sides of the landfill. Nested monitoring wells have been selected to provide an early indication of vertical gradients, and also to provide evidence of any changes in groundwater quality with depth.

The purpose of phase II groundwater investigation will be to determine the vertical and horizontal extent of any groundwater contamination which was identified in the Phase I investigation. If Phase I results indicate that there is a significant plume of VOC contamination in the groundwater, it may be appropriate to map the extent of the plume by field screening so that Phase II monitoring wells may be placed at optimal locations to characterize the vertical and horizontal extent of groundwater impact.

Field screening could be conducted by either by soil gas analysis of gas extracted from the vadose zone or head space analysis on groundwater samples. Tracer Research or a similar subcontractor could be used to perform either of the field screening techniques. Tracer operates a field vehicle which drives a small diameter hydraulic probe 5 to 15 feet into the ground to collect an air sample or groundwater sample for immediate analysis in the on-board gas-chromatograph (GC). The GC can report in concentrations to a few parts per billion, and can be calibrated either for aromatic hydrocarbons or chlorinated solvents. The method allows a relatively large number of samples to be collected and analyzed in a few days, thereby providing data for mapping the extent of a plume.

It is currently anticipated that approximately 10 additional monitoring wells will be installed and sampled in Phase II of the investigation. The exact number and location will be selected on the basis of Phase I results and any field screening which is conducted. Table 6 diagrams the decision process which will be followed in monitoring well placement and sampling.

Water levels will be measured at the staff gages, headwells, and monitoring wells throughout the investigation. Water levels will be collected approximately every 60 days during the investigation, beginning during the first month of the investigation and continuing every other month during the year-long Remedial Investigation. Two additional measurements (for a total of eight) will be conducted during periods of aquifer stress, such as immediately after a significant rainfall event, or during an extended period of drought or minimal precipitation. The water levels will be used to construct plan view and cross-sectional potentiometric maps to evaluate potential groundwater flow paths.

Aquifer tests will be conducted at each of the monitoring wells constructed during each investigation phase at the site to aid in the analysis of spatial variations or trends in hydraulic conductivity beneath the site. Estimates of hydraulic conductivity will be used in conjunction with water table maps, potentiometric maps and gradient calculations, to derive estimates of groundwater flow rates and potential contaminant migration rates.

Groundwater Quality Sampling

As has been previously detailed, monitoring well installations are currently planned for two phases of the investigation. The primary purpose of monitoring well installation and groundwater sampling will be to determine the vertical and horizontal extent of any contaminant plume deriving from the landfill. Two sampling rounds will be conducted at each monitoring well constructed in Phase I and II.

In accordance with the Statement of Work, it will be unnecessary to analyze groundwater samples for semi-volatile compounds if semi-volatile compounds are not found in the landfill samples. Therefore, it will be important to have obtained validated sampling results from the landfill headwells before Phase I monitoring well samples are collected and analyzed.

In general, the Round 1 analyses will include the Target Analyte List (TAL) parameters and Target Compound List (TCL) parameters, (as modified by landfill headwell sampling results). Round 2 sampling will be conducted at wells after results of Round 1 are known; the list of analyses will be reduced to include only the parameter groupings which were indicated in the Round 1 results. For example, if only volatile organic contaminants are found in MW-1 during Round 1 sampling, it will only be necessary to analyze for VOCs in samples collected at MW-1 during Round 2 sampling.

Two phases of investigation have been developed in detail to make optimal use of site information as it is derived to produce the information which is necessary to complete the EA and the FS. A specific scope of work for a third phase of investigation would be developed if and when it is determined from data collected in previous phases that additional information will be necessary to complete the objectives of the RI/FS. The investigation schedule is graphically displayed in Figure 5. It should be recognized that the exact number, location, depth, and type of samples are subject to change as information becomes available during the RI, if necessary to satisfy the requirements of the RI/FS, as outlined in the SOW and AOC.

SUBTASK 6D - LANDFILL CHARACTERIZATION

The characterization will be primarily to evaluate it as a potential source at the site. The characterization will include:

1. Landfill Leachate Sampling
2. Landfill Gas Sampling
3. Waste Volume Calculation
4. Landfill Cap Evaluation
5. General Evaluation of Landfill Hydraulics

Some of the methods of collecting this information have been discussed in previous sections. Other details proposed for characterizing the landfill are described in the following.

Landfill Leachate Sampling

The landfill represents the potential source of contamination. Therefore, it will be important to document the characteristics of the leachate within the landfill. In addition, in accordance with the SOW, the results of landfill sampling will be used in selecting analytical parameters for monitoring well sample analyses. Therefore, landfill headwell construction and sampling will be conducted early in Phase I of the investigation.

Borings will be made at five locations in the landfill to install leachate head wells and/or leachate gas vents. Assuming that leachate is present, a leachate head well will be placed at the boring location, screened through the entire saturated thickness of refuse, to provide samples of representative leachate and landfill gas. (The intent is to construct a leachate headwell in each of four quadrants and in the center of the landfill). If the borehole is dry, and does not contain leachate, it will be sealed and a second borehole will be made in the same quadrant, 50 to 100 feet distant from the first attempt. If it contains leachate, the headwell will be placed at that location. If the second location is also without leachate, a gas vent will never-the-less be placed at that location. The preliminary landfill boring/leachate head well locations are shown on Figure 8.

Schedule 80 PVC material will be used for leachate head well construction to minimize the potential for bending or crushing after placement within the landfill. The screened portion of each well will be extended above the zone of saturation to allow landfill gases to vent

through the well. If at some time after construction, leachate levels rise above the screen slotting, it may be necessary to lift the well and re-establish its reference elevation.

The first round of samples will be collected at the landfill head wells; analyses will include the TAL, TCL, and inorganic indicator compounds including: chloride, sulfate, total Kjeldahl nitrogen, ammonia, nitrate plus nitrite, total phosphorus, COD, and total dissolved solids. The leachate headwells are scheduled to be the first wells constructed at the site. Additionally, sampling will be conducted immediately so that sampling results will be known by the time the Phase I monitoring well sampling is conducted. For Round 2, the parameter list may be reduced to include only those groups of contaminants detected in Round 1 leachate samples.

Additional investigation may be necessary in Phase II if high contaminant loading in a leachate head well (for example, percent levels of volatile organics) coincide with large geophysical anomalies. Additional investigation may include intrusive techniques such as test borings, test pits or additional head wells.

Landfill Gas Sampling

Subtask 6A provides for the measurement of the concentration and methane gas emanating from the 5 leachate head wells which will be installed on the landfill. Gas samples will be collected from the two landfill wells which show the highest HNu readings or pressure, and analyzed for priority volatile organic pollutants.

Waste Volume Calculation

The five borings made in the landfill for the placement of leachate head wells, will be extended through the entire thickness of the refuse, allowing a documentation of the refuse thickness. A split spoon sample will be attempted at each 5 foot interval to provide an indication of the bottom of the refuse. Boring logs will be kept by the supervising field geologist or technician for each of the borings made. This information will be used with other information regarding the horizontal extent of the landfill to make a rough estimate of the volume of refuse buried in the landfill. In addition, the leachate levels collected at the leachate head wells as a part of Subtask 6C will be used to derive an estimate of leachate volumes.

Landfill Cap Evaluation

Landfill caps serve to limit infiltration and leachate production. An assessment of the thickness, character, and continuity of the existing landfill cap will be useful in assessing the need for additional capping during remediation.

Landfill cover sampling will be conducted during Phase I when borings are being made to construct the five leachate head wells. The drill rig will advance a 30-inch shelby tube, if possible, to obtain relatively undisturbed cover material samples. If cover soils vary by depth, individual samples of the various cover layers will be selected for material testing. The samples will be analyzed for permeability, sieve and hydrometer (grain size) and Atterberg Limits.

Collection of the samples may not be possible due to the compressibility of subsurface material, or the presence of granular or obstructive material. If samples cannot be removed by these methods, drill cuttings will be used to run sieve and hydrometer and Atterberg Limits to estimate cover material permeabilities.

If the results of the Phase I analysis indicate that the existing cap is effectively limiting infiltration across the whole landfill, or across major portions of the landfill, the cap evaluation will be expanded in Phase II of the investigation. The Phase II evaluation will consist of setting up a grid across the zone or zones in which the cap is indicated to be effective, and collecting up to an additional 15 continuous core samples from the landfill surface to refuse. These additional samples will also be analyzed for permeability, sieve and hydrometer (grain size) and Atterberg Limits, as appropriate.

General Evaluation of Landfill Hydraulics

A general understanding of the leachate production rate and estimate of landfill hydraulics will be useful in evaluating the landfill as a potential contaminant source. A water balance method will be used to derive an estimate of the percentage of the average annual precipitation which has the potential to become leachate in the landfill.

The U.S. EPA's Hydrologic Evaluation of Landfill Performance (HELP) numerical model (Schroeder et al., U.S. EPA, 1974) will be used to conduct the water balance. The model performs a sequential daily analysis to determine runoff, evapotranspiration, lateral drainage, and percolation from the base of a simulated landfill cover for a given precipitation record. Climatic data will be obtained for local conditions from the National Weather Service for period of the investigation. A rain gage will be installed at the Woodstock Public Works facility on the southeastern part of the site. Daily precipitation amounts will be collected for the duration of the field investigation and used in the water balance calculation of potential leachate generation.

The HELP model is capable of providing precise calculations of landfill cap and liner performances when the characteristics of the cap and liner are known in detail. However, it should be recognized that the precision of leachate calculation will be limited for the Woodstock landfill because of the limited information which is available regarding the construction of the landfill.

The HELP model will be used to derive a rough indication of the hydraulic performance of the in-place cover using information including cover thickness, soil type, and vegetative growth conditions identified for the site. Data collected during review of existing information will be used for determining cover percolation depths and porosity. Other soil characteristic input data required for analysis includes field capacity, wilting point, hydraulic conductivity, evaporation coefficient, and a Soil Conservation Service (SCS) runoff curve number.

On-site conditions such as surface slopes, ponded areas, exposed waste areas and condition of the vegetation will be considered in assessing existing cover percolation. Where site specific soil data is not available, the default data for soil characteristics (maintained within the HELP model) will be used for the soils as described by both USCS and USDA classifications.

The HELP model may also be used in the Feasibility Study if it is appropriate for the design and analysis of possible landfill capping scenarios.

SUBTASK 6E - SOILS AND LANDFILL DRAINAGEWAY SAMPLING

Past and current surface water flow routes have been evaluated as a part of Subtask 1B. A site contour map (Drawing 1) has been developed and potential flow paths have been evaluated. Historical aerial photographs, from 1967, 1972, 1974, 1976, 1980, and 1987 have been evaluated to identify potential longterm or ongoing runoff and runoff areas. In addition, several trips have been made to the landfill by Warzyn personnel to field check map and aerial photograph observations. The following observations support the conclusion that soil erosion and surface water runoff from the landfill do not represent a migration pathway for contaminants.

- The landfill was a trench and fill operation, so the refuse was buried primarily below grade.
- The overall topography of the landfill is a gentle slope from north to south.
- Since landfill closure, there has been settlement in many areas, so the precipitation falling on the landfill collects in hollows and depressions, and does not runoff the landfill.
- The site exhibits lateral berms along the west and southwest border. While these may represent local runoff areas, only the precipitation falling directly on the sloped berm will runoff the landfill.
- Since the landfill was closed by adding the clay cover, the sediment which could potentially be transported from these berms consists of cover material and not waste.
- Any erosion and runoff which does occur to the west and south from the landfill, would migrate via the marshy zone southwest and south of the site. The potential that these areas represent migration pathways will be evaluated in other subtasks of this investigation.
- Sludges from the sewage treatment plant were landfarmed on the landfill surface between 1983 and 1988 under a permit from IEPA. Sewage sludge residuals are characteristically low solubility materials, so they do not represent an endangerment to surface water or groundwater.

However, to confirm these conclusions, the following activities will be conducted during Phase I of the investigation: 1) surface water runoff and runoff routes will be mapped, 2) leachate seeps will be observed, documented and plotted on a site base map, and 3) locations of direct runoff from exposed waste will be documented. Supporting data will also be included in the Landfill Cap Evaluation (Subtask 6D), soils characterization (Subtask 6C) and Surface Water/Sediment Sampling (Subtask 6F).

SUBTASK 6F - SURFACE WATER/SEDIMENTS INVESTIGATION

Surface water and sediment sampling will be conducted in both Phases I and II. Phase I sampling will be conducted to determine if runoff or leachate leakage has impacted areas surrounding the site. Phase II sampling will be reserved to further evaluate the extent of impact at locations where impact is shown to have occurred by the Phase I results.

Sediment samples will be collected at eight locations in Phase I. The locations have been selected to represent both current surface water migration pathways and those which may have been present during site operation. Each sample will be analyzed for TCL and TAL parameters. The general locations of Phase I sediment samples are shown on Figure 9. Precise locations are plotted on Drawing 1. The Phase I sediment sampling points include: two sediment samples northwest of the landfill (SD-1 and SD-2), three sediment samples in the marshy area located south the landfill (SD-3, SD-4, and SD-5), one sediment sample in a low interior part of the landfill (SD-6), and two sediment samples located in the marshy area at the north end of the eastern border of the landfill (SD-7 and SD-8). The base map coordinates for each sampling location are listed in Table 7. Four additional samples are allocated for Phase II to document the extent of impact if Phase I results indicate that sediment contamination has extended off site.

These samples for chemical analyses are grouped in four general areas surrounding the landfill. Geotechnical analyses will be conducted on one sample from each of these four areas to evaluate the physical characteristics of sediment in each area. The physical analyses will be conducted on SD-1, SD-4, SD-6, and SD-7 and will include: grain size analysis, ion exchange capacity, total porosity, and total organic carbon.

Two surface water bodies are located in the Woodstock Landfill vicinity. One is the excavation area, north of Davis Road, and the other is Kishwaukee Creek which flows northwest to southeast past the southwest corner of the landfill. Because the excavation area is across Davis Road, beyond a topographic ridge, from the landfill, it is not susceptible to impact by surface water or sediment migration. A staff gage will be located in the excavation area to document its potential relationship to groundwater beneath the landfill.

Kishwaukee Creek flows past the landfill on the southwest and southern boundary. On several site visits by U.S. EPA and Warzyn, a liquid has been observed discharging into the Kishwaukee Creek south of the landfill. During Phase I, a sample will be collected of the liquid and analyzed for TCL and TAL parameters. The location is shown on Figure 9. If the sample indicates contaminant migration into the creek, Table 4, the sampling decision tree will be used to identify any additional sampling which may be necessary during Phase II of the investigation. In accordance with the SOW, sampling in additional phases could include surface water sampling.

Staff gages, installed as a part of Subtask 6C, the Hydrogeologic Investigation, will provide data to document surface water elevations surrounding the site (locations are shown on Figure 7). Measurements at these, in conjunction with water levels in the monitoring wells will aid in determining the interaction and relationships between surface water and groundwater in the vicinity of the landfill. A basic calculation of the surface water flow rate in Kishwaukee Creek will be made by estimating channel cross section and measuring the velocity of flow on the surface of the water.

A Preliminary Risk Assessment will be completed as a Technical Memorandum (Task 10) at the end of Phase II on the basis of data collected in Phases I and II. If the Preliminary Risk Assessment indicates that the surface water and sediment surrounding the Woodstock Site represent a hazard to the environment, additional investigation and

evaluation may be necessary in a third phase of the investigation. Phase III activities might include additional toxicity testing of surface water and sediment samples and gathering necessary supplemental data regarding terrestrial and aquatic species for inclusion in the Final Endangerment Assessment.

SUBTASK 6G - AIR

Air monitoring will be conducted by the field investigation team throughout the remedial investigation as part of the Health and Safety monitoring. The results of screening will be documented in field notes and can be reviewed with the U.S. EPA. Procedures are documented in the site specific Health and Safety Plan. It is anticipated that there will be no need to conduct detailed analysis of airborne contaminants.

Two landfill gas samples will be collected as a part of Subtask 6D, Landfill Characterization. The samples will be analyzed for the volatile organic compounds in the TCL. The data will be used in the Endangerment Assessment to determine potential risk from airborne contaminants.

SUBTASK 6(H) - WETLAND INVESTIGATION

Wetland Delineation

The objectives of the wetland delineation for the Woodstock Site are to: 1) determine the characteristics of the wetlands affected by releases of hazardous substances from the site since December 1980, 2) classify the wetlands in terms of their natural resource value in the event that filling activity performed as part of the remedial action adversely affects the wetland, 3) determine the extent wetlands have been affected by releases of hazardous substances from the site since December 1980, and 4) determine the ARARs that may have to be complied with. It will not be the purpose of the investigation to delineate or assess wetlands which have not been affected by past disposal, or will not be affected by remedial activities which include filling. To facilitate the collection of sufficient data to meet the objectives of the RI/FS, the wetlands delineation will be conducted in phases.

The first phase of the wetlands evaluation will include the delineation of wetland soils in a 100-foot buffer zone surrounding the landfill (the zone is shaded on Figure 10). Delineation will begin with an examination of existing information such as the National

Wetland Inventory Map and county soil surveys to determine if on-site work is needed to delineate wetlands, in accordance with the Federal Manual Identifying and Delineating Jurisdictional Wetlands (Interagency Cooperative Publication, January 1989). Factors to be considered include:

- Hydrophytic vegetation
- Hydric soils
- Wetland hydrology

If it is observed that a transition zone from wetland to non-wetland soils occurs just beyond the 100 foot buffer zone, it may be appropriate to extent the delineation to document the transition.

Any necessary on-site work will be performed during the vegetation growing season, ideally in late spring when hydrological conditions are optimal. The routine on-site procedure will be used because of the limited size of the areas. Depending on whether data is already available, areas of Obligate, Facultative Wetland, and Facultative plant species will be visually located (U.S. Corps of Engineers Wetland Delineation Manual: Appendix C - North Central States). A visual assessment of dominance by these species will be recorded from 100% dominance to areas of 50% (non-dominance). Soils along this gradient will be probed to a depth of 18 in. Hydric soils, as defined by the Soil Conservation Service (U.S. Department of Agriculture), and evidence of persistent saturation of mineral soils (in the form of mottling or gleying) will be noted for the soil profiles. Evidence of wetland hydrology will also be noted. Such evidence may include:

- Standing water within 18 in. of the ground surface in auger holes
- Watermarks on trees
- Absence of leaf litter or a drift line
- Sediment deposits on plants
- Encrusted detritus
- Drainage patterns

A Routine On-site Determination Method Data Form will be completed for areas delineated on-site. Other documents which may be useful include:

National List of Plant Species that Occur in Wetlands: Illinois, U.S. Dept of the Interior, Fish and Wildlife Service, 5/88.

Hydric Soils in Illinois, Soil Conservation Service, 10/87.

Soil samples will be collected in the field by hand-coring to establish the shallow soil profile, and aid in classification of the soil type. To demark the wetland areas from the non-wetland areas, a line of surveyors' flagging or pin flags will be placed along the edge of the identified wetland, then the flagged lines will be marked on the site base map. Physical markings (flagging), which may be of use for potential further site activities, may persist for several seasons.

Wetland Evaluation. The results of the wetland delineation will be supplemented with the Preliminary Risk Assessment (Task 10) to evaluate whether the surface water and sediment surrounding the site represent a hazard to the environment. The Preliminary Risk Assessment will be used to determine if additional evaluation, sampling, or testing are necessary to meet the objectives of the RI/FS. If additional sampling and field work are required, it would be conducted simultaneously with the third phase of investigation.

TASK 7 - SITE INVESTIGATION ANALYSIS

Subtask 7A - Sample Analysis/Validation

The purpose of the data management program is to assure that the data collected during the investigation is of adequate quality and quantity to support the Risk Assessment and Feasibility Study. Warzyn will implement a data management system which has been successfully used on other NPL RI/FS projects. It includes maintaining field logs, sample management and tracking procedures, and document control and inventory procedures for both the laboratory data and field measurements. (See QAPP for details).

Warzyn will provide CLP-level Laboratory Data Validation of CLP laboratory data including:

- A check of the data package for each sample analysis to verify that each of the instrument printouts is included and that the data package is complete, and
- Verification that Quality Control was completed for each packet.

A quality assurance and data sufficiency evaluation will be performed to assure that the investigative data are sufficient in quality and quantity to support the EA and FS. The evaluation will be submitted in draft to the IEPA and U.S. EPA for review.

Subtask 7B - Data Evaluation

Data evaluation will be both an ongoing exercise during the investigation, and will be formalized by production of several technical memoranda (Task 10) and the RI report.

Subtask 7C - Baseline Risk Assessment

The overall objective of the Endangerment Assessment (EA) process is to identify and characterize immediate and potential risks to public health and the environment associated with hazardous substance release. The EA integrates information on the toxicity of identified compounds with estimates of exposure to quantify risk, which in turn, provides justification necessary for remedial actions. The EA assesses the baseline risks at the site assuming "no action" to remediate the site.

The EA for the Woodstock Landfill Site will be consistent with the U.S. EPA guidance; Risk Assessment Guidance for Superfund (RAGS, 1989) the Superfund Exposure Assessment Manual - Final Draft (1988), and Risk Assessment Guidelines for Superfund - Environmental Evaluation Manual - EPA/540/1- 89/001A, March 1989.

The EA process is divided into four components, as follows:

- Contaminant identification
- Exposure assessment
- Toxicity assessment
- Risk characterization

Contaminant Identification

The aim of contaminant selection is to identify a limited number of substances from the total possible contaminants to arrive at a representative group of high risk substances for subsequent characterization. This is accomplished by screening initial sample information and selecting substances based on factors which may influence their potential risk, such as concentration at the site, potential critical exposure pathways and the intrinsic toxicity of the compound.

Exposure Assessment

The aim of this component of the EA process is to estimate exposure levels using a stepwise process which identifies and integrates actual and potential exposure pathways with potentially exposed human and environmental populations. This is accomplished by first determining the source mechanism of substance release into the environment, which involves estimating the potential release rate of the chemical from its source. Secondly, the environmental fate of the substance is evaluated. In this step, the phenomenon of environmental transport (e.g., groundwater migration); transformation (e.g., biodegradation) and transfer (e.g., volatilization) is considered. In the third step, potential exposed populations are identified. Finally, the uptake and absorption of the substances by the exposed populations are calculated to determine expected exposure levels.

Toxicity Assessment

In this aspect of the EA process, existing literature is reviewed and the toxic effects of the substances are evaluated to determine the nature and extent of the hazards associated with exposure to the substances. A qualitative description of the toxic effects, as well as quantitative data such as no-effect levels and established acceptable levels, are described to generate toxicity profiles for each substance.

Risk Characterization

Characterization of risk requires integrating information developed during the exposure and toxicity assessments. Exposure levels from the various pathways are compared with "acceptable levels" defined by regulatory legislation and guidelines to determine if the substances pose a risk. The risk characterization addresses several types of actual and potential risks, including carcinogenic risks and non-carcinogenic risks, and the additive risk associated with more than one substance.

Endangerment Assessment Report

A Preliminary Risk Assessment will be completed as a Technical Memorandum (Task 10) after Phase II of the RI. The Endangerment Assessment Report will be completed as a section in the RI Report.

TASK 8 - LABORATORY AND BENCH SCALE STUDIES

If findings from the Phase I and II investigation indicate that one or more of the feasible remedial alternatives are likely to include some innovative technologies, it will be necessary to conduct bench-scale and/or pilot-scale testing studies to determine technology applicability to the site conditions.

Therefore, treatability studies may be considered after the second phase of the investigation on the basis of the existing information. The overall purpose of treatability studies will be to assess whether a given innovative or untested technology can be implemented, and/or to judge its effectiveness for use at the site. If treatability studies are found to be necessary, a work plan will be prepared to outline the purpose and procedures of the study or studies and will be submitted to the U.S. EPA for review and comment.

TASK 9 - COMMUNITY RELATIONS

Community relations generally will be the responsibility of the U.S. EPA RPM and U.S. EPA Community Relations staff. The PRPs and Warzyn will, at the request of the U.S. EPA RPM, participate in the community relations activities as they are needed at the site. Community relations support will be consistent with the Superfund community relations policy, as stated in the 'Guidance for Implementing the Superfund Program' and Community Relations in Superfund - A Handbook."

TASK 10 - RI REPORTS AND GENERAL REPORTING

Three categories of reports will be generated during the RI/FS: progress reports, technical memoranda, and Draft and Final RI and FS Reports.

Monthly Progress Reports

Monthly progress reports will be prepared to describe the technical progress of the RI/FS. The reports will be submitted to the U.S. EPA and IEPA by the tenth business day of each month. They will include the following information.

1. A description of the actions which have been taken toward achieving compliance with the AOC.
2. Results of quality assured sampling and tests produced or received during the month and relating to the facility.

3. Copies of boring logs, water level measurements, precipitation and other field data which is generated during the month.
4. All plans and procedures completed during the previous month, as well as such actions, data, and plans which are scheduled for the next month.
5. Target and actual completion dates for each element of activity, including the project completion, and an explanation of any deviation from the schedules in Figure 5.
6. Changes in personnel to include changes in telephone numbers and addresses during the previous month.
7. A description of any difficulties encountered in performing work during the reporting period and the relevant actions taken to rectify them.

Technical Memoranda

Technical memoranda will be prepared to describe the procedures used to collect specific data and will present the preliminary data. Copies will be sent to the U.S. EPA and IEPA for review. A meeting will be held between the U.S. EPA RPM and Warzyn to discuss the findings and the appropriate level of effort for each subsequent phase of the investigation. Warzyn will also present a written summary of proposed sampling and investigation for each necessary subsequent phase of investigation. The information included in the technical memoranda will be incorporated into the draft and final Remedial Investigation Report. Five technical memoranda will be produced during the Remedial Investigation. If necessary, memorandums will be updated at the end of subsequent phases.

1. Wetlands Delineation
2. Phase I Hydrogeologic Study
3. Surface Water/Sediment Evaluation
4. Source Characterization
5. Endangerment Assessment

Remedial Investigation Report

A final report covering the investigations will be prepared following the general outline presented in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, EPA/5540/G-89/004, October 1988.

Section 1 will provide an introduction to the project including a review of the project history, and a summary of the report organization.

Section 2 will describe the study area investigation, detailing the procedures used in the investigation.

Section 3 will present the site characterization, by summarizing the natural systems, including, meteorology, surface and groundwater flow systems, geology, and hydrogeology.

Section 4 will present the natural and contaminant chemical characterization of the site.

Section 5 will discuss contaminant and location specific ARARs and associated data needs.

Section 6 will discuss the contaminant fate and transport of the specific contaminants found in the migration pathways at the site.

Section 7 will be a baseline risk assessment.

Section 8 will present the summary and conclusions from the site investigation.

The RI Report will be submitted in draft form to the U.S. EPA and IEPA for review. Upon receipt of comments, a draft final report will be prepared and submitted.

SECTION 6 **FEASIBILITY STUDY TASKS**

The purpose of the Feasibility Study (FS) for the Woodstock Landfill site is to develop and evaluate alternative remedial actions, and to present the relevant information needed to allow for the selection of a site remedy which will be protective of human health and the environment.

The FS will conform to Section 121 of CERCLA; the NCP, as amended; the FS Guidance, as amended; and U.S. EPA policy. The FS is comprised of the following tasks:

- Task 11: Remedial Alternatives Identification and Screening
- Task 12: Remedial Alternatives Array Document
- Task 13: Remedial Alternatives Evaluation
- Task 14: Feasibility Study Report
- Task 15: Community Relations Program
- Task 16: Additional Requirements

TASK 11 - REMEDIAL ALTERNATIVES IDENTIFICATION AND SCREENING

The identification and screening of remedial alternatives will be accomplished through implementation of the four interrelated subtasks:

- Subtask 11(A) - Preliminary Remedial Technologies
- Subtask 11(B) - Development of Remedial Alternatives
- Subtask 11(C) - Screening of Alternatives
- Subtask 11(D) - Data Requirements

The work to be accomplished under each subtask is discussed below.

Subtask 11(A) - Preliminary Remedial Technologies

The purpose of this subtask is to identify and consider a wide range of potentially applicable technologies and, based on site and waste conditions, identify a limited number of specific process options that may be used to address site problems. Conceptually, the screening process may be viewed as consisting of the following:

- Development of general response actions.
- Identify volumes or Areas of Media
- Identification of the general technology types associated with the general response actions.
- Identification of process options associated with each technology type.
- Screening technology types and process options based on an evaluation with respect to technical implementability.

General response actions will be developed for each media of concern at the Woodstock Landfill site. Response actions may include source control measures or treatment, migration control measures or both, depending on the media and/or exposure pathways that may need to be addressed. Response actions will consider the general area(s) of concern and quantity of material to be remediated at the site based upon the initial site evaluation and information from the RI as it becomes available.

Technologies and process options that cannot be effectively implemented at the site will be eliminated from further consideration. This screening will be based on information from the RI and on technology capabilities/limitations. Results of the screening will be summarized in tables and text form.

For each of the technology types considered potentially applicable, one or normally two process options will be selected for further consideration. Process options will be further evaluated in the following subtasks, using effectiveness, implementability and relative cost. Limiting the number of specific process options is intended to make the development and screening of alternatives more manageable by limiting the potential number of alternatives developed. *Selecting specific process options for actual implementation is a Remedial Design (RD) phase activity.* Results of the process options evaluation will be presented in tabular form with supporting narrative text.

Subtask 11(B) - Development of Remedial Alternatives

Under this subtask, a range of remedial alternatives will be developed for the site. This subtask is comprised of the four steps described below which may be viewed as involving more specific definitions of potential remedial activities.

Establishment of Remedial Action Objectives - Site-specific objectives for the remedial action will be established for the Woodstock Landfill site; considering the description of the current situation, information gathered during the RI, Section 300.68 of the National Contingency Plan (NCP), the U.S. EPA's interim guidance, and the requirements of other applicable U.S. EPA, Federal, and Illinois environmental standards, guidance and advisories.

These objectives consist of medium-specific or operable unit-specific goals for protecting human health and the environment. They will specify: the contaminant(s) of concern; exposure route(s) and receptor(s); and an acceptable contaminant level or range of levels for each exposure route.

Acceptable exposure levels for human health will be determined on the basis of risk factors and contaminant-specific ARARs. Contaminant levels in each media will be compared with these acceptable levels, which will be determined on the basis of an evaluation of the following factors:

- For carcinogens, whether the chemical-specific ARARs provides protection within the risk range of 10^{-4} to 10^{-6} and whether achievement of each chemical-specific ARAR will sufficiently reduce the total risk from exposure to multiple chemicals. The 10^{-6} level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure.
- For non-carcinogens, whether the chemical-specific ARAR is sufficiently protective if multiple chemicals are present at the site.
- Whether environmental effects (in addition to human health effects) are adequately addressed by the ARARs.
- Whether the ARARs adequately address all significant pathways of human exposure identified in the baseline risk assessment. For example, if exposure from the ingestion of fish and drinking water are both significant pathways of exposure, application of an ARAR that is based only on drinking water ingestion (e.g., MCLs) may not be adequately protective.

If an ARAR is determined to be protective, it will be used to establish the acceptable exposure level. If not (presents a risk greater than 10^{-4}), or doesn't exist for the specific

chemical or pathway of concern, or multiple contaminants may be posing a cumulative risk, acceptable exposure levels will be identified through the risk assessment process. The Risk Assessment Guidance for Superfund (RAGS, 1989) will serve as the primary source of guidance for risk assessment.

Clearly, the determination of acceptable exposure levels will depend on the availability of site investigation results. Where possible, preliminary response objectives will be established based on existing site information and a qualitative assessment of potential risks. Response objectives will be revised as information from the RI becomes available.

Alternatives Remedial Actions - Alternatives will be assembled by combining general response actions and the process options chosen to represent the various technology types for each media or operable unit. Alternatives will be formulated to provide comprehensive site remedies. Alternatives to be developed will include the following:

- a. Treatment alternatives for source control that eliminate or minimize the need for long-term management (including monitoring).
- b. Alternatives involving treatment as a principal element to reduce the toxicity, mobility or volume of waste.

At least two additional alternatives will be developed, including the following:

- a. An alternative that involves containment of waste with little or no treatment but provides protection of human health and the environment primarily by preventing exposure or reducing the mobility of the waste.
- b. A no action alternative.

Subtask 11(C) - Initial Screening of Alternatives

The purpose of this subtask is to narrow the list of potential alternatives that will be evaluated in detail. The screening is accomplished using the following steps:

- Alternatives will be further refined as appropriate;
- They will be evaluated on a general basis to determine their effectiveness, implementability, and cost; and
- A decision will be made, based on this evaluation, as to which alternatives should be retained for further analysis.

Alternatives Definition - In this step, alternatives will be further defined to form a basis for evaluating and comparing them prior to screening. Sufficient quantitative information to allow differentiation among alternatives with respect to effectiveness, implementability, and cost is required. The following information will be developed, as appropriate, for the various technology processes used in an alternative:

- size and configuration of on-site extraction and treatment systems or containment structures;
- time frame in which treatment, containment, or removal goals can be achieved;
- process flow rates and/or rates of treatment;
- spatial requirements for constructing treatment or containment technologies or for staging construction materials or excavated soil or waste;
- distances to disposal or treatment facilities; and
- required permits and imposed limitations.

Initial Screening - In this step, defined alternatives will be evaluated against short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. These are described as follows:

- **Effectiveness**: Alternatives will be evaluated to determine whether they adequately protect human health and the environment; attain Federal and Illinois ARARs or other applicable criteria, advisories, or guidance; significantly and permanently reduce the toxicity, mobility, or volume of the hazardous constituents; are technically reliable; and are effective in other respects. The consideration of reliability will include the potential for failure and the need to replace the remedy.
- **Implementability**: Alternatives will be evaluated as to the technical feasibility and availability of the technologies that each alternative would employ; the technical and institutional ability to monitor, maintain, and replace technologies over time; and the administrative feasibility of implementing the alternative.
- **Cost**: The cost of construction and long-term costs to operate and maintain the alternative will be evaluated. This evaluation will be based on conceptual costing information and not a detailed cost analysis. At this stage of the FS, cost will be used as a factor when comparing alternatives that provide similar results,

but will not be a consideration at the screening stage when comparing treatment and non-treatment alternatives.

Preservation of Alternatives - In this step, alternatives with the most favorable composite evaluation of all factors are retained for further consideration during detailed analysis. Alternatives selected will preserve the range of treatment and containment technologies initially developed plus the no action alternative.

Subtask 11(D) Data Requirements

The purpose of this subtask is to provide data not available from the RI to support the detailed analysis of alternatives in Task 13. The need for additional data, if any, will be identified. Additional data gathering may involve site characterization, waste characterization, exposure pathway characterization, other materials testing or treatability studies. Data requirements will be approached in two steps as described below.

Determination of Data Requirements - Additional data needs, if any, will be identified by assessing the unknowns associated with the site and/or the application of specific technologies at the site. A literature survey will be conducted to determine whether adequate performance and application data exist for a particular technology, and to determine testing requirements.

Treatability Testing or Field Investigation - If needed, the purpose of this step would be to plan, carry out, evaluate and report on the supplemental field or treatability investigation. Investigations or testing may be required to adequately evaluate a specific technology for application at the site. The evaluation may be oriented toward a performance assessment, process sizing, materials identification and testing (e.g., NR512 clay borrow source search and clay testing) or cost estimation. The goal of investigation or testing is to support the remedy-selection process. In general, the following activities would be included in the subtask:

- Work Plan preparation (or revisions to existing Work Plan);
- Field Investigation or sampling, and/or laboratory testing, and/or pilot-scale testing;

- Analysis of data from the investigation or testing program; and
- Report preparation.

Because of the unknowns at this stage of the process, no specific program is proposed or budgeted in this Work Plan.

TASK 12 - REMEDIAL ALTERNATIVES ARRAY DOCUMENT

The purpose of this task is to provide the basis for the determination of possible action specific applicable or relevant and appropriate requirements (ARARs). A description of the screened alternatives retained in Subtask 11(C) (including extent of remediation, contaminant levels to be addressed, and methods of treatment) will be presented. This document will also include a brief site history and background, a site characterization summary that includes contaminants of concern, migration pathways, receptors, and other pertinent site information. This Alternatives Array Document will be submitted to the U.S. EPA and the IEPA, along with the request for notification of the standards and requirements. If needed, a meeting will be scheduled between the U.S. EPA, IEPA, and Warzyn to discuss the Alternatives Array Document and ARARs.

TASK 13 - REMEDIAL ALTERNATIVES EVALUATION

Section 121 (b)(1)(A-G) of CERCLA outlines general rules for cleanup actions, and establishes the SARA statutory preference for remedies, in which treatment permanently and significantly reduces volume, toxicity, or mobility of hazardous substances, pollutants and contaminants. Further, it directs that the long-term effectiveness of alternatives be specifically addressed and that at a minimum the following be considered in assessing alternatives:

- A. The long-term uncertainties associated with land disposal;
- B. the goals, objectives, and requirements of the Solid Waste Disposal Act;
- C. the persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bioaccumulate;
- D. Short- and long-term potential for adverse health effects from human exposure;

- E. Long-term maintenance costs;
- F. the potential for future remedial action costs if the alternative were to fail; and
- G. the potential threat to human health and the environment associated with excavation, transportation and redisposal, or containment.

The Remedial Alternatives Evaluation task is basically a three-stage process consisting of the following:

- Development of detailed alternatives,
- Analysis of alternatives, and
- Comparison of alternatives.

Subtask 13(A) - Development of Detailed Alternatives

Each alternative will be defined in sufficient detail to facilitate subsequent evaluation and comparison. Typically this activity may involve modification of alternatives based on ARARs, refinement of quantity estimates, technology changes, or site areas to be addressed. Prior to detailed definition, the final conceptual alternatives will be agreed on by Warzyn, the Respondents, IEPA and the U.S. EPA RPM.

Subtask 13(B) - Analysis of Alternatives

Alternatives will be initially evaluated with respect to seven criteria. The seven criteria encompass: technical, cost and institutional considerations and compliance with statutory and regulatory requirements. Each factor is briefly discussed below.

- **Overall Protection** The assessment against this criterion describes how the alternative as a whole achieves protection and will continue to protect human health and the environment.
- **Compliance with ARARs** The assessment against this criterion describes how the alternative complies with ARARs, or, if a waiver is required, how it is justified.
- **Long-term Effectiveness and Permanence** The assessment of alternatives against this criterion evaluates the long-term effectiveness of alternatives in protecting human health and the environment after response objectives have been met.

- **Reduction of Toxicity, Mobility and Volume** The assessment against this criterion evaluates the anticipated performance of the specific treatment technologies.
- **Short-term Effectiveness** The assessment against this criterion examines the effectiveness of alternatives in protecting human health and the environment during the construction and implementation period until response objectives have been met.
- **Implementability** This assessment evaluates the technical and administrative feasibility of alternatives and the availability of required resources.
- **Cost** This assessment evaluates the capital and O&M costs of each alternative.

The final criteria, state or support agency acceptance and communicated acceptance, will be evaluated following comment on the RI/FS report. The criteria are as follows:

- **State Acceptance** This assessment reflects the State's (or support agency's) apparent preferences among or concerns about alternatives.
- **Community Acceptance** This assessment reflects the community's apparent preferences or concerns about alternatives.

Subtask 13(C) - Comparison of Alternatives

After each alternative has been analyzed against each of the criteria, a comparative analysis will be conducted. The purpose of this analysis is to compare the relative performance of alternatives with respect to each evaluation criterion. The narrative discussion will describe the strengths and weaknesses of the alternatives relative to one another with respect to each criterion, and how reasonable variations of key uncertainties could change the expectations of their relative performance. If innovative technologies are being considered, their potential advantages in cost or performance and the degree of uncertainty in their expected performance (as compared with more demonstrated technologies) will also be discussed. A table will be prepared summarizing the assessment of each alternative with respect to each of the nine criteria.

TASK 14 - FEASIBILITY STUDY REPORT

Feasibility Study activities and results will be described and documented in a report. The FS report will be organized following the outline suggested in Table 6-5 of the Guidance

for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, October 1988.

The project schedule, Figure 5, allows four months for completion of the FS.

A technical memorandum will be prepared for each of Tasks 11, 12, and 13 and submitted sequentially at approximately one month intervals for U.S. EPA review and comment. A meeting will be scheduled to discuss U.S. EPA and IEPA comments, if any, prior to preparation of the draft final report by Warzyn. The FS report will not be considered "draft final" until a letter of approval is issued by the U.S. EPA RPM.

TASK 15 - COMMUNITY RELATIONS PROGRAM

A program for community relations support will continue throughout the FS, to the selection of a site remedy. The program will be consistent with the Community Relations Plan developed under Task 6 and with the conditions set forth in the Administrative Order by Consent.

TASK 16 - ADDITIONAL REQUIREMENTS

If, necessary, additional requirements will be developed to meet the objectives of the FS.

SECTION 7 **SCHEDULE**

The schedule for completion of the RI/FS defined in this Work Plan is presented in the timeline chart, Figure 11. It indicates significant milestones as well as elapsed time for each task. Specific timeframes are included in the schedule for periods of review and comment by the U.S. EPA. Any additional review time required by the U.S. EPA or IEPA will result in corresponding increases in the schedule.

The estimated time for completion of the Remedial Investigation is 365 days from receipt of the U.S. EPA's approval of the RI/FS Planning documents submitted by the PRP group. The draft Feasibility Study report will be submitted to the U.S. EPA and IEPA 120 days following receipt of U.S. EPA approval of the RI report.

Table 1
Schedule of Key Events and Deliverables.

<u>Event/Deliverable</u>	<u>Due Date</u>
Submittal of Final Planning Documents	
RI/FS Field Mobilization	14 days after receipt of U.S. EPA approval of Planning Documents
Draft RI Report	365 days after receipt of U.S. EPA approval of Planning Documents
Re-Draft of RI Report	45 days after receipt of U.S. EPA review comments
Submittal of Final RI Report	30 days after receipt of U.S. EPA review comments
Draft FS Report	120 days after receipt of U.S. EPA approval of the Final RI Report
Re-Draft of FS Report	45 days after receipt of U.S. EPA review comments
Submittal of Final FS Report	30 days after receipt of U.S. EPA review comments

Note:

If due date falls on week end or Holiday, the due date will be considered the next available working business day.

TABLE 2 SUMMARY OF WATER SUPPLY WELLS IN THE VICINITY OF THE SITE

Map #	Owner	Location	Distance from Site	Date Drilled	Screened Interval	Formation (s)	Use of Well(b)	Well Dia.	Static WL (below TOC)	Pumping Data
PW-1	Wally Williams	14023 South St.	1.7 miles W-NW	10-22-85		Limestone	Home	5	85	Water level 180 ft at 7 gpm
PW-2	C.J. Bach	1911 Dean St.	4000 ft NW	11/2/76	338-355	Limestone	Home	5	120	Water level 220 ft at 10 gpm for 2 hrs.
PW-3	Berthold Nurselee	South St.	1.5 miles NW	8/2/73	385	Shale	Home	5 (PVC)		
PW-4	Ted Beardsley		4800 ft NW		332-342	Rock				
PW-5	Carmen Costanzo		4800 ft N	1956	69	Sand & Grvl			15	
PW-6	Gold Seal Builders	Rt. 47 & 14	3800 ft NE	8/18/73	241-245	Limestone		5	80	Water level 80 ft at 20-30 gpm
PW-7	Frank Andree	NW NW NW	1.25 miles N	9/2/72	105	Grvl		5		
PW-8	Ralph McConnel		1.0 mile NE	8/11/70	110-113	Clay		5	40	Water level 79 ft at 18 gpm for 1 hrs.
PW-9	Fred McConnell		1.25 mile NE	1941	125	Grvl				
PW-10	John Emery		1.2 mile N-NE	1941	56	Grvl		6		Water level 24 ft at 6 gpm, Gradual Drawdown at 7.5 gpm
PW-11	Elizabeth Pattinson	1650' E 100' S	1.2 miles N-NE	1944	73	Grvl		5	30	
PW-12	Marilyn Brenten	11701 Country Club Rd.	1.4 mile N-NE	3/20/89	60-63	Sand & Grvl	Home	5	20	Water level 40 ft at 13 gpm for 2 hrs.
PW-13	Walt Dolecke	934 McConnell Rd.	4000 ft NE	11/17/87	275-300	Limestone	Home	5	110	Water level 110 ft at 10+ gpm for 2 hrs.

TABLE 2 SUMMARY OF WATER SUPPLY WELLS IN THE VICINITY OF THE SITE, Continued

Map #	Owner	Location	Distance from Site	Date Drilled	Screened Interval	Formation (a)	Use of Well(b)	Well Dia.	Static WL (below TOC)	Pumping Data
PW-14	Don Larson	South side Country Club Rd.	1.5 mile N-NE	1942	78	Sand & Grvl		4.5	14	Water level 28 ft at 12 gpm for 0.5 hrs.
PW-15	Harding Real Est.	11106 Rt. 14	1.2 mile E-SE	10/8/83	56-66	Grvl	Home	5	45	Water level 45 ft at 20 gpm for 5 hrs.
PW-16	Horst Art	11906 Noveen Pkwy	2800 ft SE	9/20/70	150-180	Sand & Grvl		6	48	Water level 65 ft
PW-17	Memorial Park Cemetery		1.1 mile E	Oct 1940	130	Grvl	Cemetery	5		
PW-18	Woodstock Storage Garage		2000 ft NE	1967	265-435	Shale/Limestone	Garage	8	96	Water level 100.7 ft at 16.5 gpm for 12 hrs.
PW-19	Robert Fitzer	12624 Davis Rd.	1400 ft NW	12/21/83	179-182	Grvl	Home	5	76	Water level 90 ft at 15 gpm for 12 hrs.
PW-20	Base Pro Shop	2015 S. Rt. 47	1800 ft NE	5/10/82	251-285	Grvl		5(PVC)	60	Water level 80 ft at 10 gpm for 4 hrs
PW-21	George Rockwood	2112 Edgewood Ln.	1200 ft NE	9/14/78	38-40	Grvl	Home	5(PVC)	20	Water level 40 ft at 8 gpm for 2 hrs
PW-22	Ted Andersen	12320 Davis Rd.	200 ft NE	12/3/76	277	Limestone (Also have inactive wellpoint 35 ft TD)	Home	5	85	Water level 105 ft at 15 gpm
PW-23	Warren Brokaw	Davis Rd.	1.0 mile W-NW	4/3/81	51-65	Grvl	Home	5	20	Water level 20 ft at 20 gpm for 3 hrs.
PW-24	D. Bufalino	8044 W. Gregory	1.8 mile SW	7/30/74	Unknown	Shale	Home	5	115	Water level 120 ft at 15 gpm
PW-25	Mavin B.		1.3 mile SW	6/12/69	185-194	Shell Rock	Home	5	70	Water level 76 ft at 16 gpm for 1 hrs.
PW-26	R. Ahrens	Dean St.	1.1 mile SW	11/21/70	200-207	Grvl	Home		65	Water level 70 ft at 8 gpm for 2 hrs.
PW-27	Unknown		1.6 mile SW		215	Rock				
PW-28	Harvey Sterke	11614 Lucas Rd.	1.1 mile S-SE	7/3/73	345	Rock	Commercial	5		
PW-29	E. Fuller	370 Lincoln	1.8 mile NW	7/74	240	Limerock	Home	5	80	< 210 ft at 3 gpm Water level 90 ft

TABLE 2 SUMMARY OF WATER SUPPLY WELLS IN THE VICINITY OF THE SITE, Continued

Map #	Owner	Location	Distance from Site	Date Drilled	Screened Interval	Formation (a)	Use of Well(b)	Well Dia.	Static WL (below TOC)	Pumping Data
PW-30	Ron O'Leary	Davis Rd.	200 ft N	7/2/70	328-342	Limestone	Home	5	85	at 18 gpm for 36 hrs.
PW-31	Frank Stipanov	Oakwood Hills Sub.	1400 ft NE	9/11/71	225-238	Sand & Grvl	Home	5	100	Water level 100 ft at 10 gpm 2 hrs.
PW-32	Hurley Motors		1400 ft NE	1986	255-280	Grvl		5	80	Water level 90 ft at 15 gpm for 5 hrs.
PW-33	B.W. McNeil	Oakwood Hills Sub.	1800 ft	1980	253-290	Rock	Home	5	90	9 gpm for 10 hrs.
PW-34	Mary Gunderson Boeswell	2218 South Dean St.	2800 ft W				Home			
PW-35	Rich Sankey	2514 Dean St.	2900 ft W		80 ft TD		Home			
PW-36	Richard & Linda Hoyt	2516 Dean St.	2800 ft W		45-60 ft TD		Home			
PW-37	Larry Peterson	2518 Dean St.	2800 ft W				Home			
PW-38	LeRoy Eddy	2804 Dean St.	2800 ft SW		70-76 ft TD		Home			
PW-39	Roy Van Wazen	2620 Dean St.	2800 ft SW		225 ft TD		Home			
PW-40	Fred & Betty Wallis	12618 Davis Rd.	800 ft NW				Home			
PW-41		12322 Davis Rd.	200 ft N				Home			
PW-42		2618 Dean St.	2800 ft SW				Home			
PW-43		2615 Dean St.	2800 ft SW				Home			
Gas Well		Mrs. Ronan: Dean & Lucas Rds	1.3 mile	11/15/68	168	Sand & Grvl	Farm	5	70 (est)	Gas 5200 cubic ft/day

(a) - Screened Interval

(b) - Use Estimated by Log

Table 3
Groundwater Sampling Decision Tree
Residential/Commercial/Municipal Wells

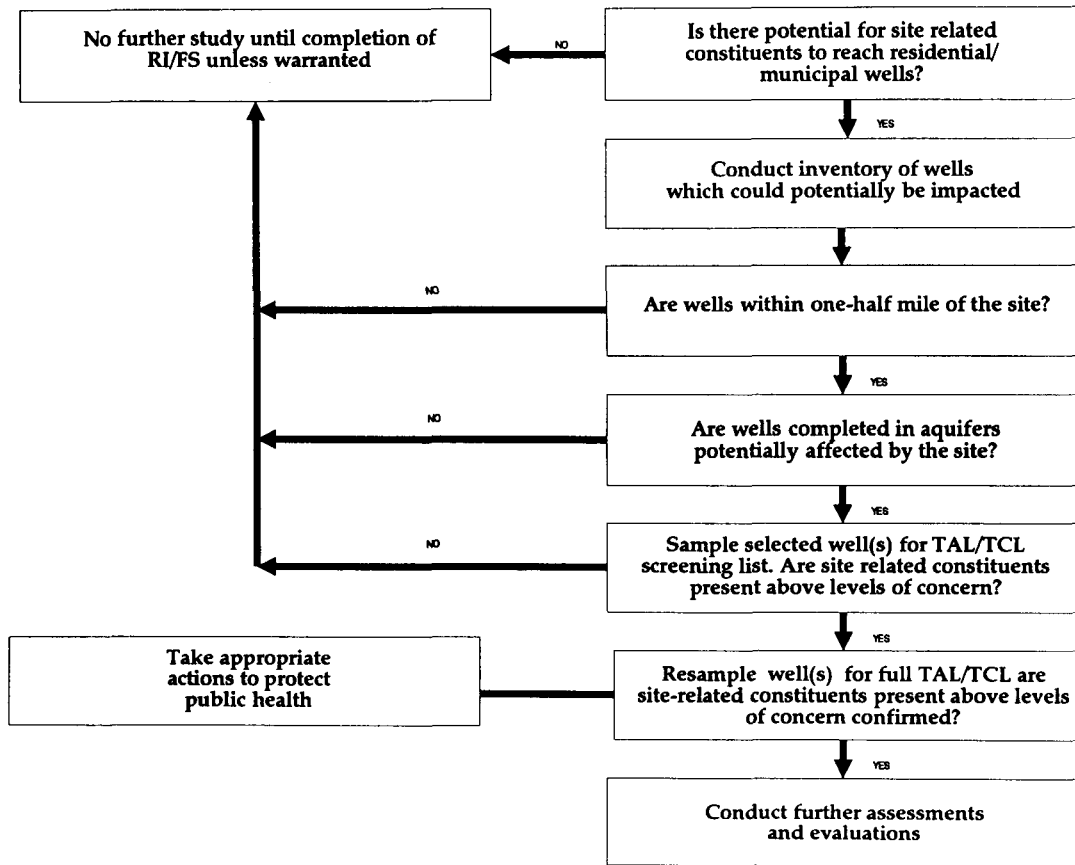


Table 4
SurfaceWater and Sediment Sampling Decision Tree

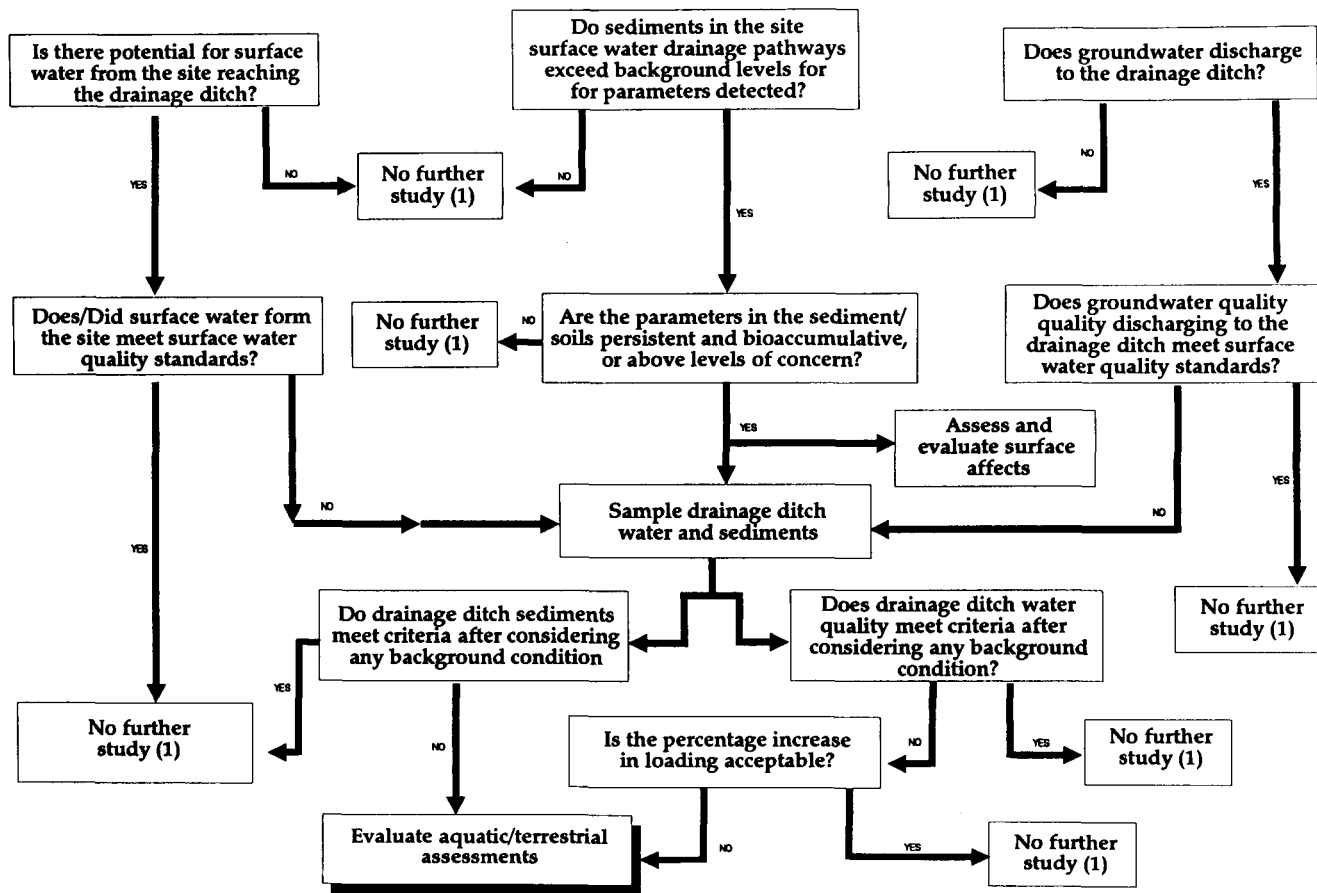


Table 5
Preliminary Summary of Data Needs

<u>Remedial Alternative</u>	<u>Data Required</u>	<u>Source of Data</u>
No-Action	Endangerment Assessment data in affected media	TAL/TCL results
Limited Action Capping Grading Berms Dikes	Borrow source characteristics 1.location 2.soil classification 3.volume of source area	Site Base Map Visual soil classification Geotechnical analysis
Cut-Off Walls	Geologic and Stratigraphic information	Geologic Cross sections vertical and horizontal hydraulic conductivity, hydraulic gradients, and geotechnical soils analysis
Groundwater (wells or trenches)	Aquifer Properties	Baildown tests Groundwater quality Radius of influence Vertical and horizontal hydraulic conductivity, and hydraulic gradients
Gas Extraction	Landfill gas characteristics cap characteristics Volume and availability of gas	HNu screening, Borings to determine cap integrity and characteristics Pilot extraction system
Leachate Extraction	Leachate volume and generation Source characterization Pilot study of system	Borings to determine cap integrity and characteristics HELP model Leachate samples Hydraulic properties of Waste, radius of influence

Table 5 (continued)
Preliminary Summary of Data Needs

<u>Remedial Alternative</u>	<u>Data Required</u>	<u>Source of Data</u>
Biological Treatment	Chemical characteristics of groundwater and leachate Identify nutrient or oxygen requirements	TAL/TCL results TOC, TKN, nitrate/ nitrite, nitrogen, total phosphate, and dissolved oxygen
Chemical Treatment	Chemical characteristics of groundwater and leachate	TAL/TCL results pH, dissolved oxygen Redox potential Treatability study
Physical Treatment	Chemical characteristics of groundwater and leachate	TAL/TCL results Henry's Law, Partition coefficients
Discharge to Surface	Chemical characteristics of groundwater and leachate	TAL/TCL results COD, TSS, pH and dissolved oxygen
Water or POTW	Chemical characteristics of groundwater and leachate Sewer use ordinances Pre-treatment requirements	TAL/TCL results Public information

Notes:

1. This table is a preliminary list of data needs for possible remedial alternatives. The RI/FS will be conducted in several phases. Some of the listed data will be collected during the Phase I Therefore, all data is not scheduled

Table 6
Groundwater Sampling Decision Tree
Monitoring Wells

Install 5 leachate wells in Landfill. Conduct Round 1 sampling at each head well for TCL, TAL, and indicator parameters.

At 6 locations surrounding landfill, install 2-well-nests of monitoring wells. Install surface water staff gages.

Collect water levels at head wells, monitoring wells and staff gages to determine groundwater gradients

Are the gradients horizontal?
Are the gradients vertical?

Conduct Round 1 sampling at each well (Sampling parameters may be reduced to include only parameters detected in leachate head well samples).

If appropriate, conduct field screening to determine extent of contaminant plume.

Construct up to 10 additional downgradient monitoring wells to document character and location of outer extent of contaminant plume.

Conduct Round 1 sampling at each new well (Sampling parameters may be reduced to include only parameters detected in leachate head well samples).

Are landfill related constituents present in monitoring wells?

Resample to confirm.

Conduct Round 2 sampling at first 12 monitoring wells. (Sampling parameters may be reduced to include only parameters detected in Round 1 samples).

Conduct Round 2 sampling at new monitoring wells. (Sampling parameters may be reduced to include only parameters detected in Round 1 samples).

Delineate contaminant plume

Evaluate Remedial Actions

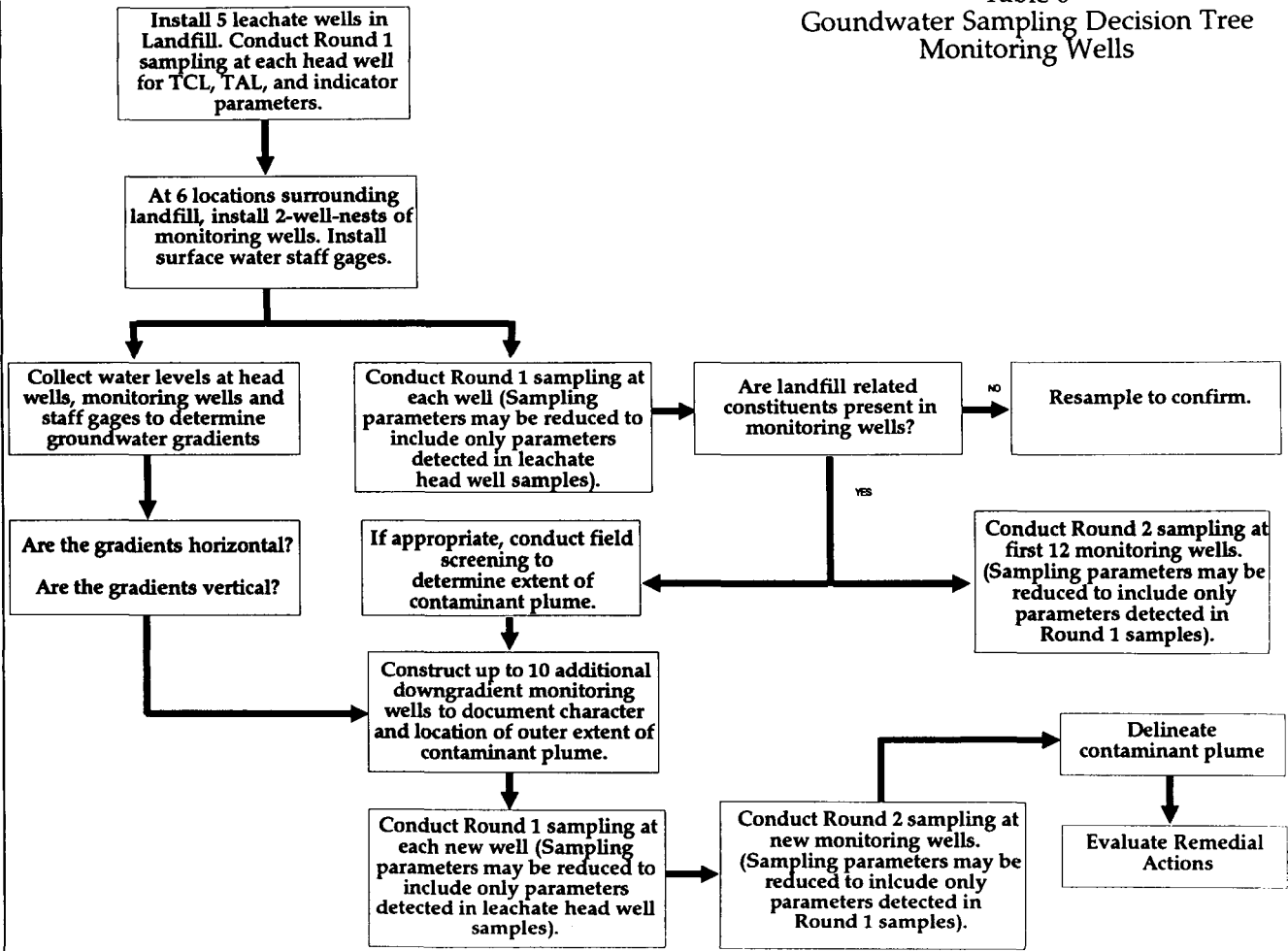


Table 7
Coordinates of Sampling Locations
Phase I Remedial Investigation
Woodstock Landfill NPL Site

<u>Sampling Point</u> <u>Identifier</u>	<u>Coordinates</u>	
	<u>South</u>	<u>East</u>
Monitoring Wells		
MW1A & MW1B	-300	1200
MW2A & MW2B	900	1400
MW3A & MW3B	1600	1000
MW4A & MW4B	1300	100
MW5A & MW5B	550	-100
MW6A & MW6B	-50	0
Leachate Head Wells		
LW1	400	350
LW2	50	850
LW3	700	700
LW4	1000	300
LW5	900	1050
Surface Water/Sediment Samples		
SW1	1350	250
SD1	150	-50
SD2	250	-150
SD3	950	-50
SD4	1350	450
SD5	1450	625
SD6	1300	800
SD7	200	1350
SD8	0	1400
Staff Gages		
SG1	-400	100
SG2	100	1350
SG3	2050	1250
SG4	1975	950
SG5	1675	550
SG6	1375	350
SG7	700	-300

Notes:

- Coordinates refer to coordinates shown on Drawing 1, Woodstock Landfill Base Map.
- Sampling locations may be modified as the field investigation proceeds.

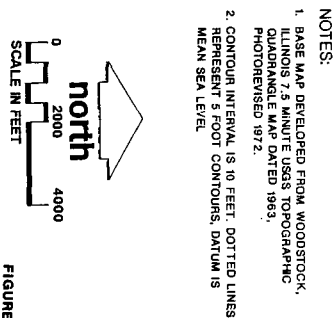
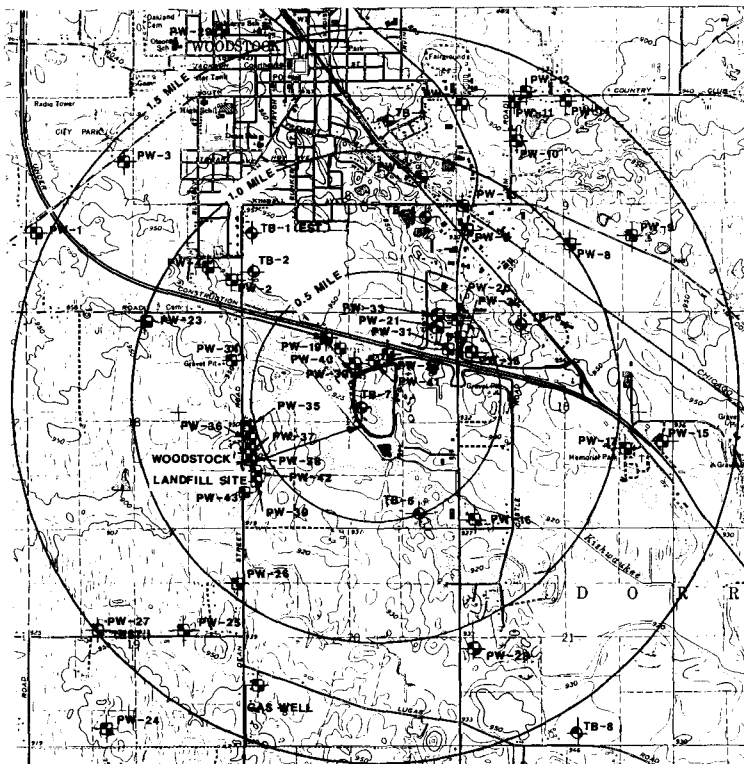


FIGURE 1





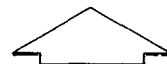


NOTES

1. BASE MAP DEVELOPED FROM WOODSTOCK, ILLINOIS 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE MAP DATED 1963 PHOTOREVISED 1972.
2. ALL WELL AND BORING LOCATIONS ARE APPROXIMATE.
3. LOCATION DATA COLLECTED FROM WELL & TEST BORING LOGS PROVIDED BY ILLINOIS STATE WATER SURVEY (ISWS).

LEGEND

- PW-1  PRIVATE WELL LOCATION
- TB-1  TEST BORING LOCATION



0 2000 4000
SCALE IN FEET

Project No.	60776
Date	12/19/80
Drawn by	WALZYN
Checked by	WALZYN
Project Name	PRIVATE WELL AND TEST BORING LOCATION/FEASIBILITY STUDY WOODSTOCK MUNICIPAL LANDFILL SITE WOODSTOCK, ILLINOIS
Sheet No.	OF 60776 B2

FIGURE 2

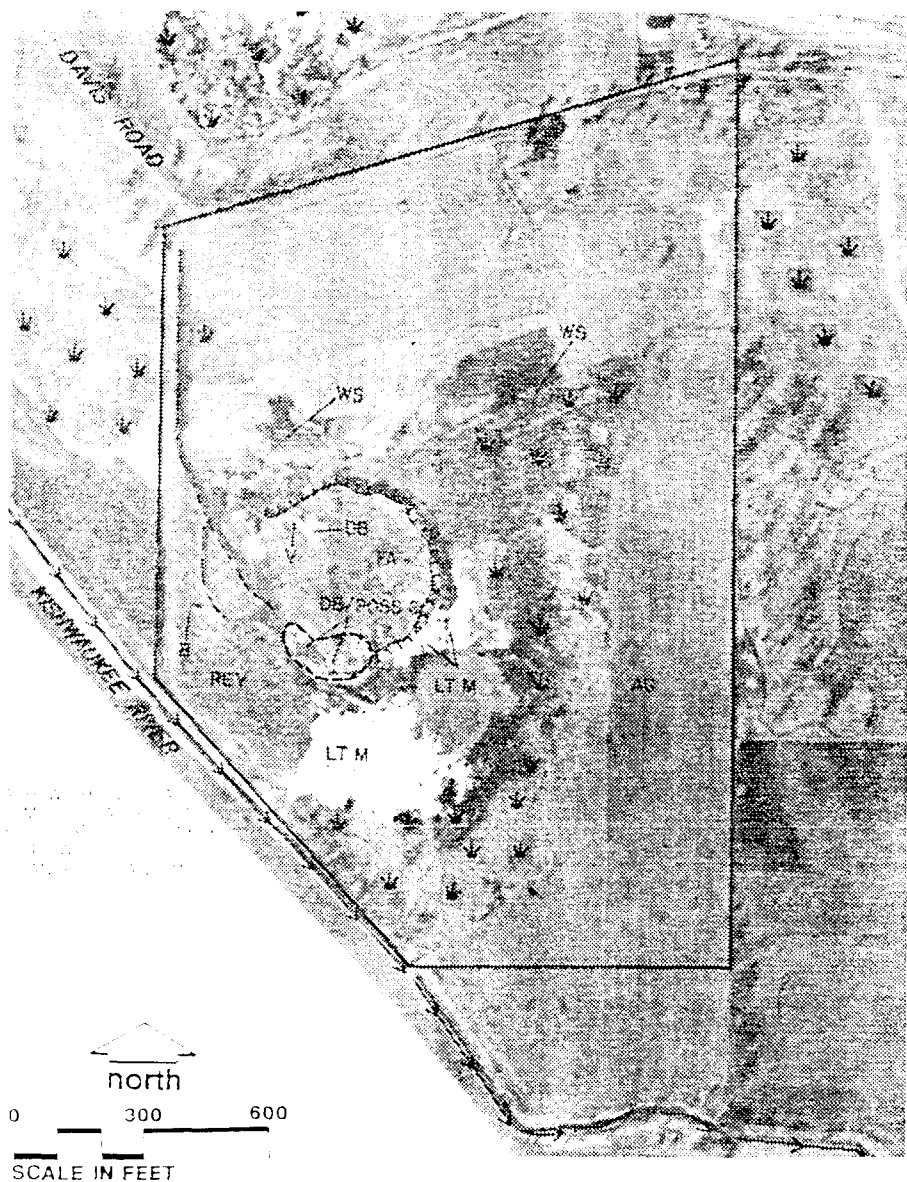


FIGURE 3

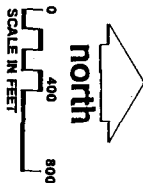


FIGURE 10

BASE MAP TAKEN FROM WOODSTOCK,
ILLINOIS, 7.5 MINUTE USGS TOPO-
GRAPHIC QUADRANGLE.

APPROXIMATE LIMITS OF FILL


SURFACE WATER

UNIMPROVED GRAVEL ROAD

 BUILDING

~~920~~ CONTOURS

 MARSH AREA

 100-FOOT BUFFER ZONE
FOR WETLAND DELINEATION

WETLAND DELINEATION ZONE

**WORK PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WOODSTOCK MUNICIPAL LANDFILL SITE**

WARZYNDesigned By *DJL*

Drawn By ELR

Entered By A. J. 30/10/01

Approved By 3017

11/20/91

Abstract

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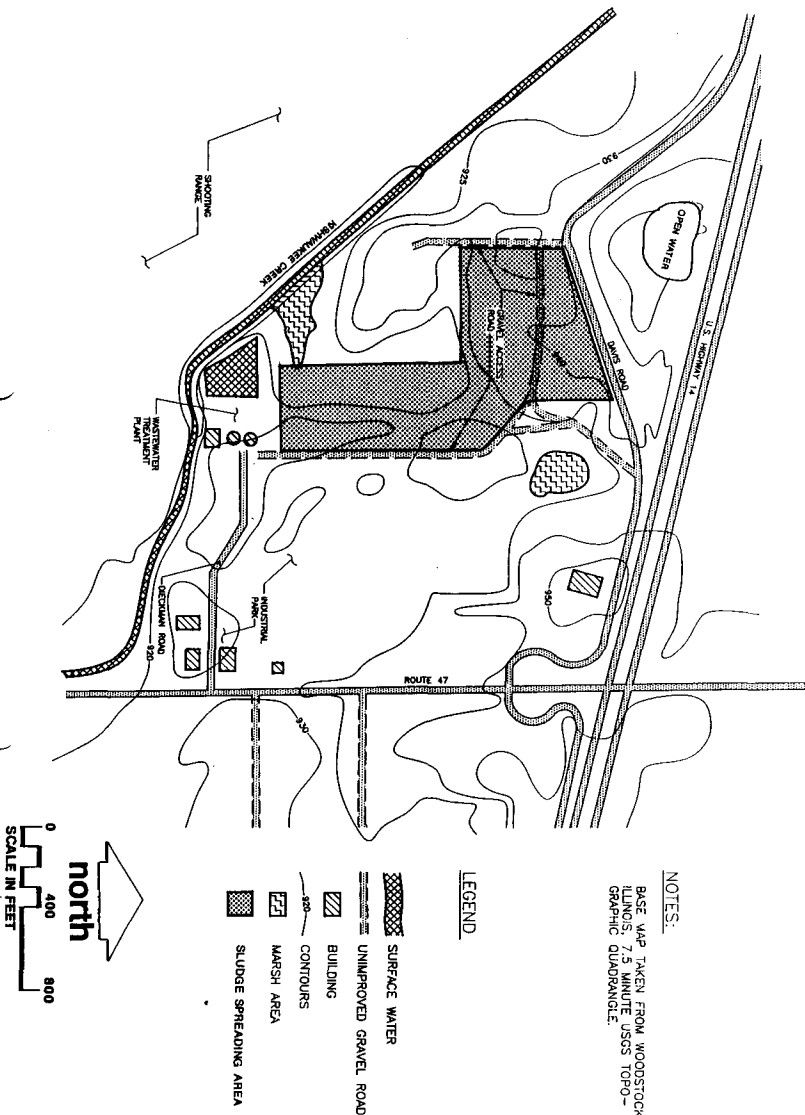


FIGURE 4

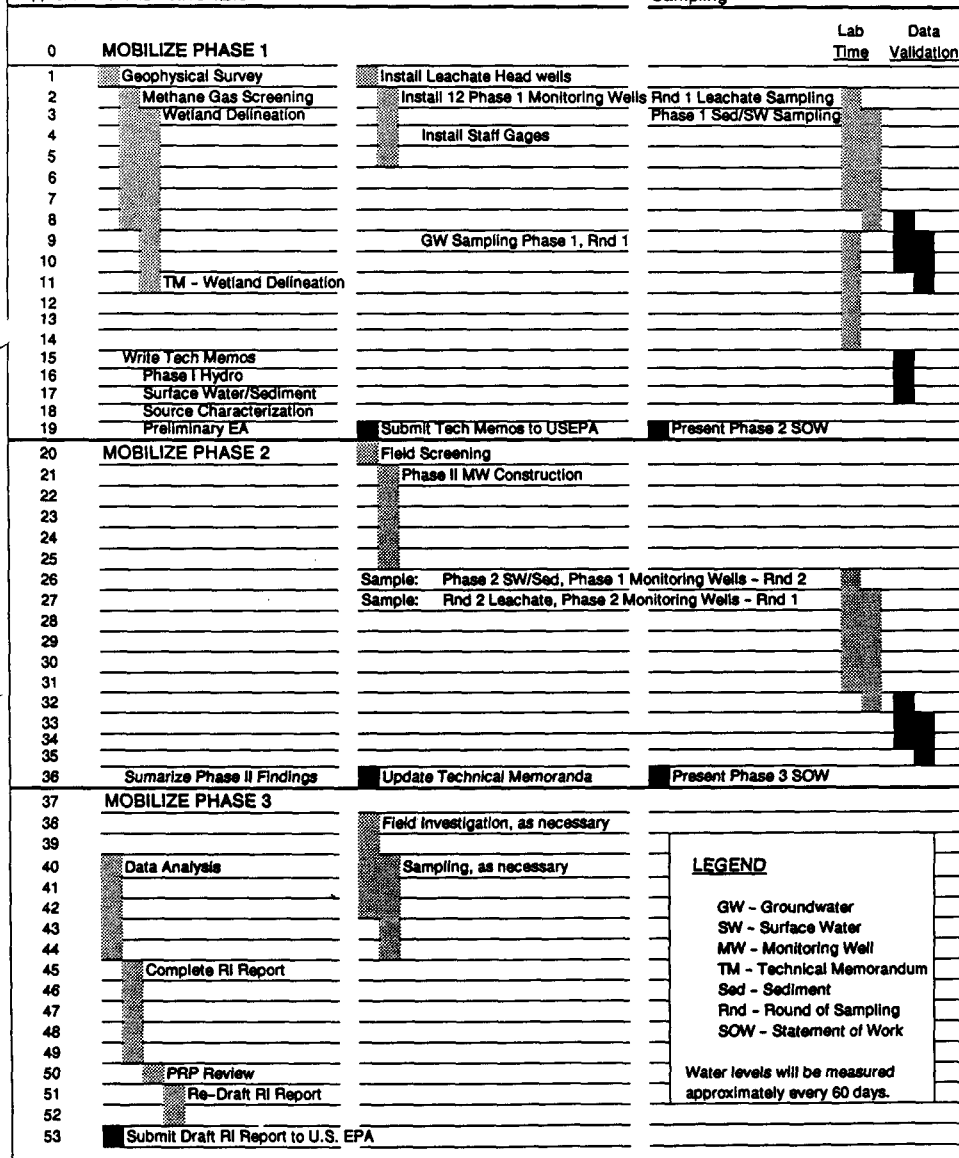
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	WORK PLAN		Approved by: [Signature]	Date: 4/20/90	Revision:
REMEDIAL INVESTIGATION/FEASIBILITY STUDY WOODSTOCK MUNICIPAL LANDFILL SITE WOODSTOCK, ILLINOIS					

Figure 5. Remedial Investigation Schedule

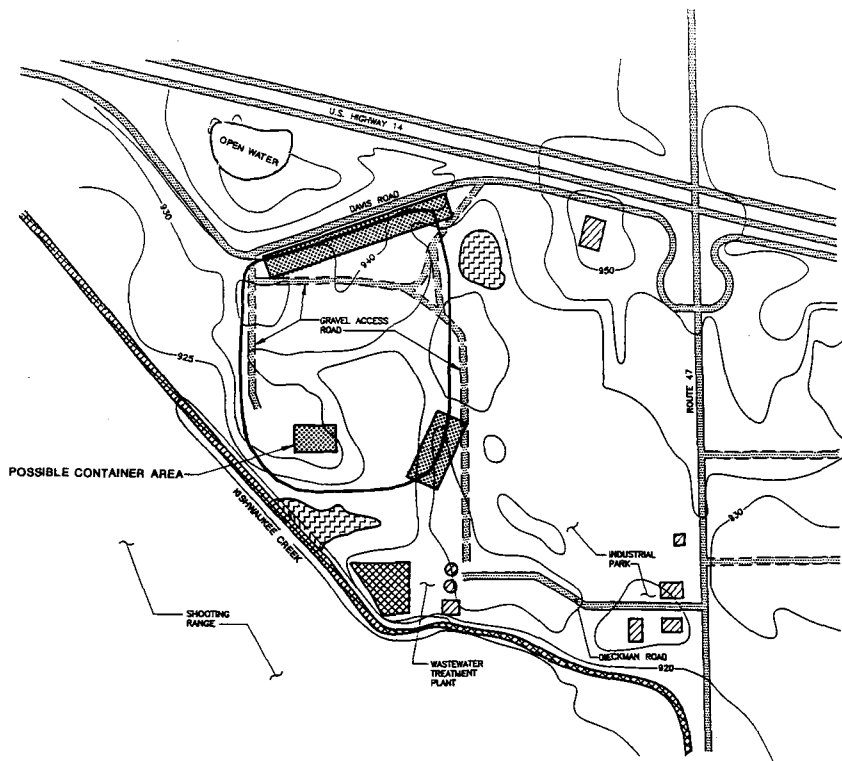
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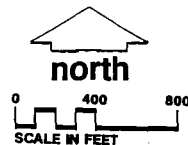


NOTES:

BASE MAP TAKEN FROM WOODSTOCK, ILLINOIS, 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE.

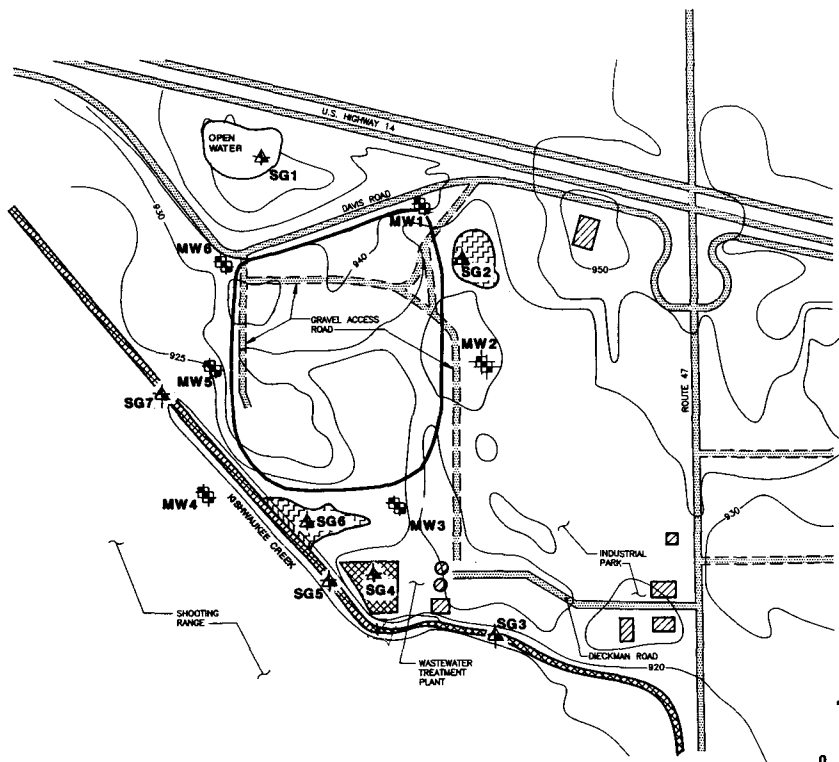
LEGEND

- APPROXIMATE LIMITS OF FILL
- SURFACE WATER
- - - UNIMPROVED GRAVEL ROAD
- ▨ BUILDING
- CONTOURS
- ▨ MARSH AREA
- ▨ AREAS TO BE GRIDDED FOR EM GEOPHYSICAL SURVEY



WARZYN	
Project No. 800	Client ECR
Drawn by JAW	Date 4/20/90
Checked by JAW	Scale
GEOPHYSICAL SURVEY AREAS	
WORK PLAN INVESTIGATION/FEASIBILITY STUDY	
WOODSTOCK MUNICIPAL LANDFILL SITE	
WOODSTOCK, ILLINOIS	
OF	84
60776	84

FIGURE 6



NOTES:

1. BASE MAP TAKEN FROM WOODSTOCK, ILLINOIS, 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE.
2. REMAINING MONITORING WELLS WILL BE PLACED FOLLOWING REVIEW OF THE FIRST ANALYTICAL RESULTS.

LEGEND

- APPROXIMATE LIMITS OF FILL
- ▨ SURFACE WATER
- UNIMPROVED GRAVEL ROAD
- ▧ BUILDING
- 920 CONTOURS
- ▧ MARSH AREA
- ✱ MW1 PROPOSED SOIL BORINGS/ MONITORING WELL NESTS AND NUMBER
- ▲ SG1 STAFF GAUGE LOCATION & NUMBER

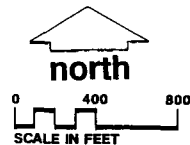
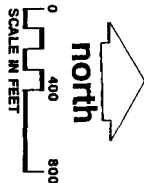


FIGURE 7



BASE MAP TAKEN FROM WOODSTOCK,
ILLINOIS, 7.5 MINUTE USGS TOPO-
GRAPHIC QUADRANGLE.

LEGEND

APPROXIMATE LIMITS
OF FILL


OF FILL

 SURFACE WATER

UNIMPROVED GRAVEL ROAD

 BUILDING

~~920~~ CONTOUR

 MARSH AREA

PROPOSED LANDFILL
BORING/LEACHATE WELL
LW1 AND NUMBER

LANDFILL BORINGS/LEACHATE WELLS

WORK PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WOODSTOCK MUNICIPAL LANDFILL SITE

DATE : / /

WARZYN

Designed By *DJD*

Drawn By ELR

Checked by: JAW

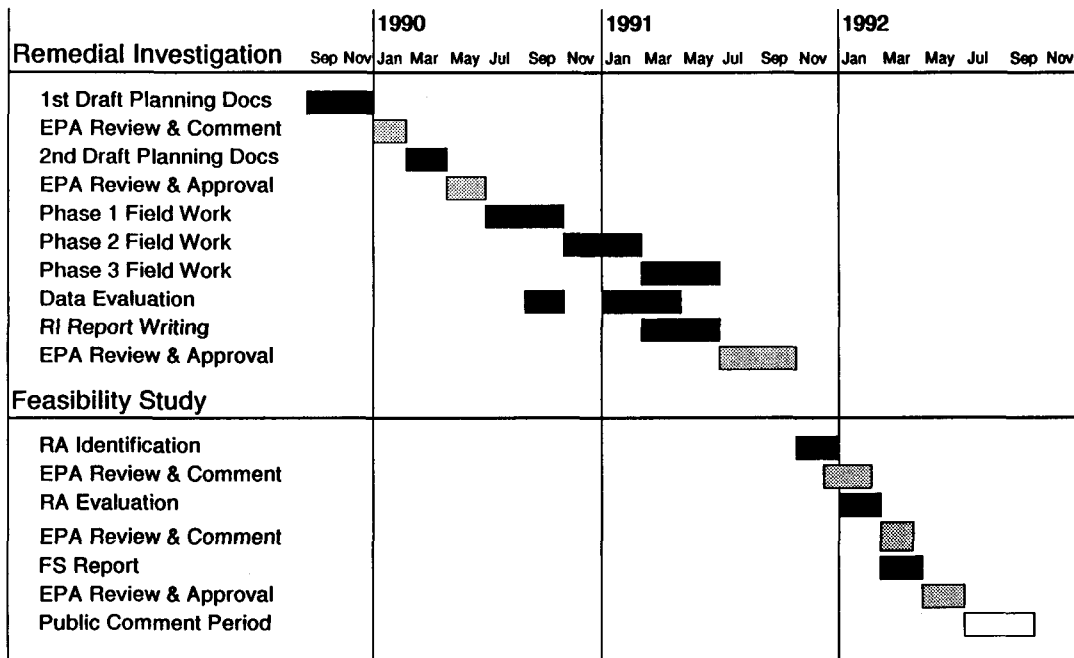
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4/20/90

60776

OF

Figure 11. PROJECT SCHEDULE



Key:



Agency review periods may vary.

APPENDIX A

**ISGS/U.S. EPA Study
Hydrogeology of Solid Waste Disposal Sites
in Northeastern Illinois, 1971**

**HYDROGEOLOGY OF SOLID WASTE DISPOSAL SITES
IN NORTHEASTERN ILLINOIS**

A Final Report on a Solid Waste Demonstration Grant Project

*This report (SW-12d) was prepared
by G.M. HUGHES, R.A. LANDON, and R.N. FARVOLDEN
the Illinois State Geological Survey, Urbana, Illinois
under Demonstration Grant G06-EC-00006
from the Federal solid waste management program*

U.S. ENVIRONMENTAL PROTECTION AGENCY

1971

PB 214 028

*Hydrogeology of
Solid Waste Disposal Sites
in Northeastern Illinois*

NATIONAL TECHNICAL
INFORMATION SERVICE

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FOREWORD

This is the final report on a study supported in part by the Solid Waste Management Office under one of the demonstration grants (No. G06-EC-00006) authorized by the 1965 Solid Waste Disposal Act. The study, conducted mainly by personnel of the Illinois State Geological Survey, was sponsored by the Survey, the Illinois Department of Public Health, and the University of Illinois at Urbana. The period of the original grant was from June 1, 1966, through May 31, 1968, and the grant was extended for an additional two years through May 31, 1970.

This demonstration study attacks one of the problems inherent in disposing of refuse on land: the ever-present danger that—unless properly engineered in a sanitary landfill—the wastes will adversely effect ground-water resources. The initial objective of the investigation was to obtain hydrogeologic information about landfills. After the first two years of work, however, it was apparent that a considerable amount of precise data on water quality could be gathered with relatively little effort or expense, and this was emphasized during the final year of the project. The present volume includes both the early and later data and thus supersedes an interim report on the project published by the Solid Waste Management Office in 1969. Although the conclusions reported apply specifically to the soil types that were tested, the procedures and methods used for the testing are applicable for future hydrogeologic-landfill research.

—RICHARD D. VAUGHAN
*Deputy Assistant Administrator
for Solid Waste Management*

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the landfill has been diluted by ground water moving into the landfill from the west.

WATER QUALITY. Figure 17 shows water quality near the Elgin landfill. The correlation between distance from the landfill and the water quality is not as good as that at the other sites. This is probably because variations in the permeability of the shallow sands and gravels allow differential lateral movement.

Dissolved solids have not and cannot move downward through the tills, because ground water movement is mainly upward or lateral under the site. The anomalous quality in LW 4C, LW 5B, and LW 6B can be accounted for by leakage between piezometers in the same borehole. Unpolluted water is moving upward from LW 4B to LW 4C, and LW 5A and LW 5B are so closely spaced and poorly sealed that samples are not representative.

On the assumption that the water in LW 1C, with a total dissolved solid content of 2,000 ppm, is representative of that entering the Fox River from the landfill, it would raise the dissolved solids level in the river by approximately 0.30 (2,000 ÷ 7,400) ppm, half of which is hardness.

The data shown in figure 17 were gathered on November 28, 1967. Analyses of samples taken on February 25, 1969, show no significant changes other than an increase in dissolved solids in water from well Number 1. The significance of this increase is not known:

WOODSTOCK LANDFILL

GENERAL DESCRIPTION. The Woodstock landfill is in McHenry County in NE¼ sec. 17, T. 44N., R. 7E., south of Davis Road. The elevation of the landfill is between 920 and 940 feet above sea level. It is in morainic topography, possibly on a stagnant-ice moraine, and lies on the top and south flank of an east-west-trending linear upland and in the swampy lowland to the south of this upland. Figure 18 is a plan view and cross section of the region.

The site was first operated as an open burning dump, beginning in June 1940. It was converted to sanitary landfill in 1965, and operations are

continuing. Early filling was in the swampy southern part of the area. The eastern and southeastern parts of the area are currently being filled. The material in the fill is reported to be about 40 percent household and garden refuse and 60 percent industrial refuse. Lime soda sludge is disposed of in the southern and southeastern parts of the fill area. Records of filling (figure 19) are not as reliable here as at the old DuPage County and Winnetka landfills.

Daily cover material is at least 6 inches thick with a final cover of 2 to 3 feet. Cover over most of the fill is loam, silt loam, silty clay loam, and sandy loam. The present landfill surface at the base of the upland is gently undulating, with patches of weeds and grass. The upland part of the landfill has a more irregular surface.

The sequence of geologic materials, from the surface downward is as follows:

Cover on landfill—approximately 2 feet of loam, silt loam, sandy loam, and silty clay loam, gravely in part.

Topsoil adjacent to landfill—1 to 2 feet of loam and sand at northern end; 1 to 4 feet of silty clay over the remainder of the site.

Swamp—peat and nonorganic silts (5 to 19 feet thick) in marshy areas around and below most of southern two-thirds of the site; thickest in the field between the landfill and the Kishwaukee drainage west of the site.

Sand and gravel—5 to 19 feet of sand and gravel generally becoming finer textured at base; sand and gravel and sandy silt till deposits present on the higher land at northern end of site; exposures indicate probable ice contact origin.

Upper till—3 to 25 feet (generally 20 feet) of silty clay till, thinner below the landfill.

Lower tills—several silty, sandy tills present to a depth of at least 225 feet at LW 1.

Interbedded sands and gravels—sand and gravel deposits commonly 5 feet or more thick, interbedded with silty sandy tills. A few of these deposits can be correlated between borings, but most cannot and are probably of limited areal extent.

Soil—3 to 5 feet soil zone encountered in two borings at a depth of 165 to 167 feet.

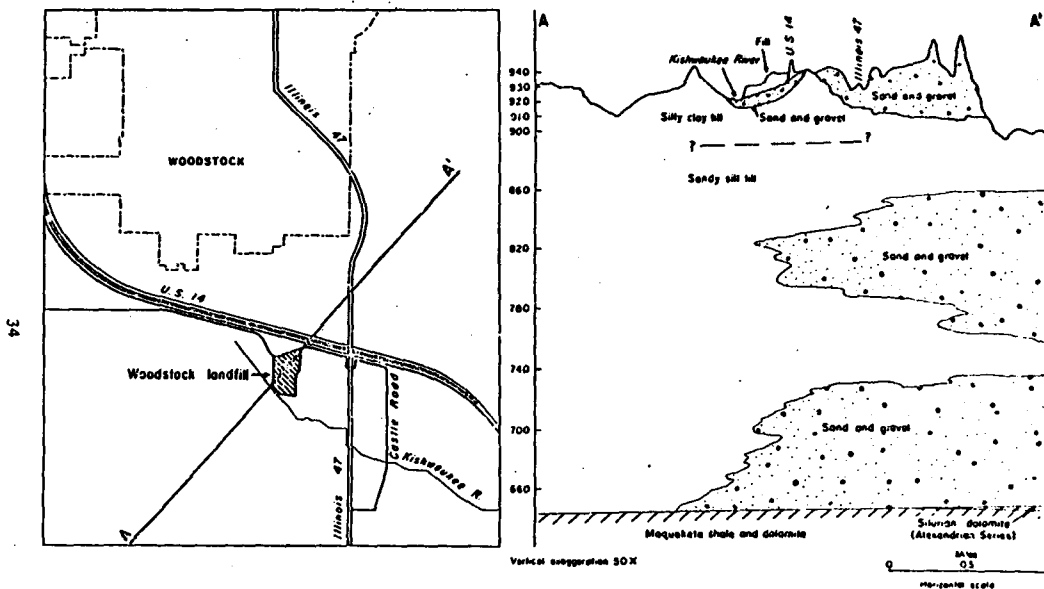


Figure 18. Map (left) shows the general area surrounding the Woodstock landfill. Cross section (right) shows the topography and general geologic sequence of the area between A and A' on the map.

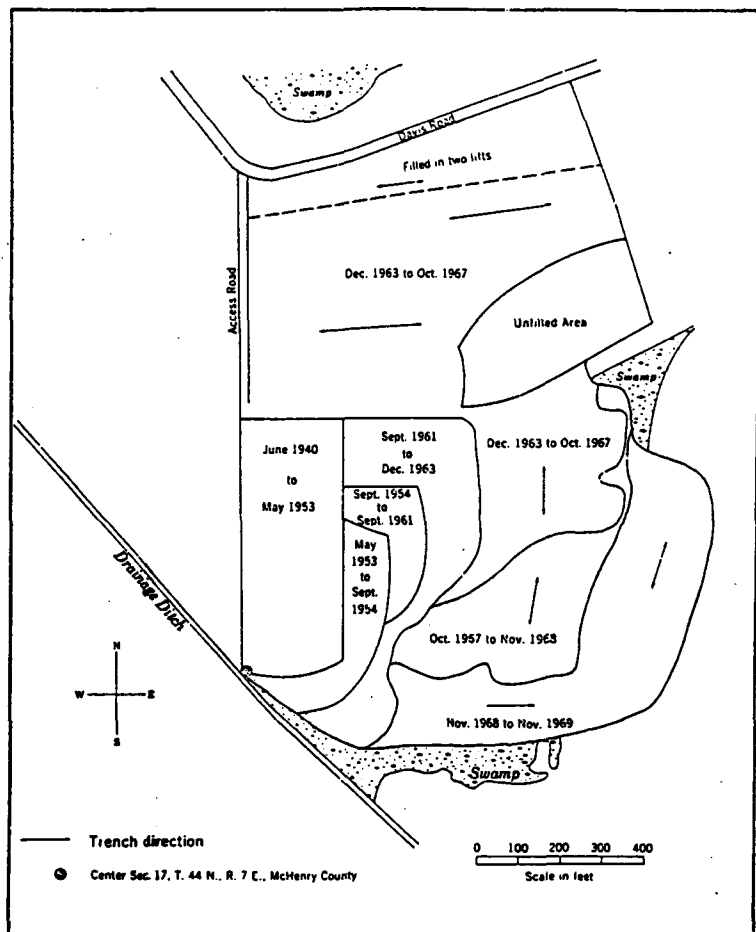


Figure 19. History of filling at the Woodstock landfill. The site was first operated as an open burning dump, from 1940 to 1955. In 1955 it was converted to sanitary landfill, and operations are continuing.

Bedrock—not encountered, but from nearby well information, it is probably at a depth of more than 225 feet and consists of shales and dolomites of the Maquoketa Group.

HYDROGEOLOGIC ENVIRONMENT. Figure 20 is a plan view of the landfill and surrounding area, showing the location of the borings and contours of the top of the zone of saturation. Gradients are away from the upland in the northern part of the landfill in all directions. In the older part of the filled area, the gradient is southward to swampy areas bordering the landfill or to the drainage ditch west and southwest of the landfill. Some influence of the landfill is shown by a steepening of gradients on the southern edge; this indicates that a small ground water mound lies below the landfill.

Figure 21 shows vertical sections across the filled area. A strong component of lateral flow in the shallow materials above the silty clay till is evident, as is a vertical gradient in the silty clay till.

A number of interbedded sands and gravels have not been shown on the Woodstock cross sections. These deposits are generally more permeable and thicker at Woodstock than at Winnetka and would tend to magnify any horizontal component of flow.

The drainage ditch west of the landfill area acts in much the same manner as the deep sewer at Winnetka, distorting the flow system and "collecting" the ground water moving from the western side of the landfill.

QUANTITATIVE EVALUATION. Infiltration into the Woodstock landfill was calculated to be 22,500 gpd. Of the 24.07 inches of rain that fell from October 1, 1968, to September 30, 1969, approximately 12 inches infiltrated.

No quantitative evaluation of flow from the Woodstock site was made, because of the complex geology and lack of data on the hydrologic properties of the materials.

The flow in the drainage ditch was estimated to 1×10^6 gpd, which allows dilution by about 45 times. This calculation does not include the water moving downward below the landfill area or dilution of the ground water leaving the land-

fill between the landfill and the ditch; it therefore minimizes the figure for dilution.

WATER QUALITY. Water quality data plotted in figure 22 show the expected inverse relationship between total dissolved solids and distance from the fill, with the exception of data from LW 2E, which is shallow, very close to the fill, and apparently unaffected. MM 6 does not show large dissolved solid content; however, the landfill upgradient from this point is relatively new and there may not have been adequate time for the leachate to move this distance.

There is no evidence of downward movement through the silty clay till at LW 3 or LW 5. Whether this is because the till has acted as a barrier to the migration of dissolved solids or whether inadequate time has elapsed is not known.

Analyses of water in the drainage ditch on January 18, 1968, and February 24, 1969 (table 6) show larger contents of chlorides opposite MM 9 than opposite MM 10. This could well be a result of ground water's containing dissolved solids from the landfill moving into the ditch, but in view of the larger concentrations of chlorides both upstream and downstream in this same ditch, the evidence is inconclusive.

Table 18 lists the wells that best show downward movement of contaminants. It is not known why LW 1B is not contaminated and LW 6A is. LW 3D is separated from the landfill by 20.5 feet of till, and data from other sites would not lead us to expect leachate in this well.

The data shown in figure 22 were gathered on November 21, 1967. Analyses of samples taken on February 25, 1969, showed the following changes:

- (1) In MM 7, large increases in alkalinity, chloride, and sodium (by difference).
- (2) In LW 1D large increases in alkalinity, calcium, and sodium (by difference) and decreases in magnesium.

These variations could reflect seasonal changes or long-term trends.

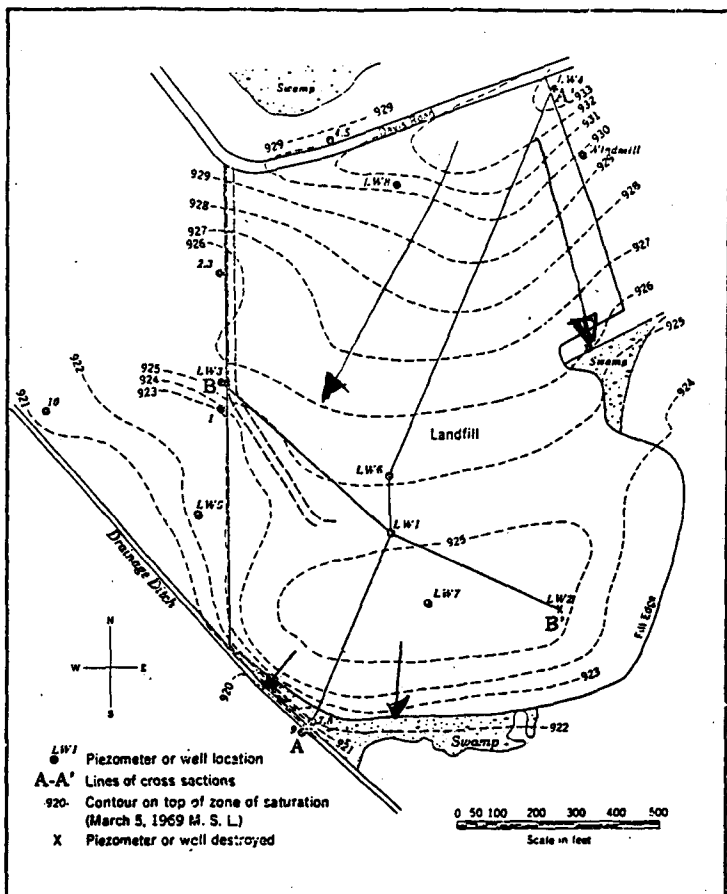


Figure 20. Plan view of the Woodstock landfill and surrounding area, showing locations of borings and the contours of the top of the zone of saturation. Gradients are away from the upland of the northern part of the landfill in all directions. In the older part of the filled area, the gradient is southward to swampy areas bordering the landfill or to the drainage ditch west and southwest of the landfill. Some influence of the landfill is shown by a steepening of gradients on the southern edge. This steepening suggests that a small ground water mound lies beneath the landfill.

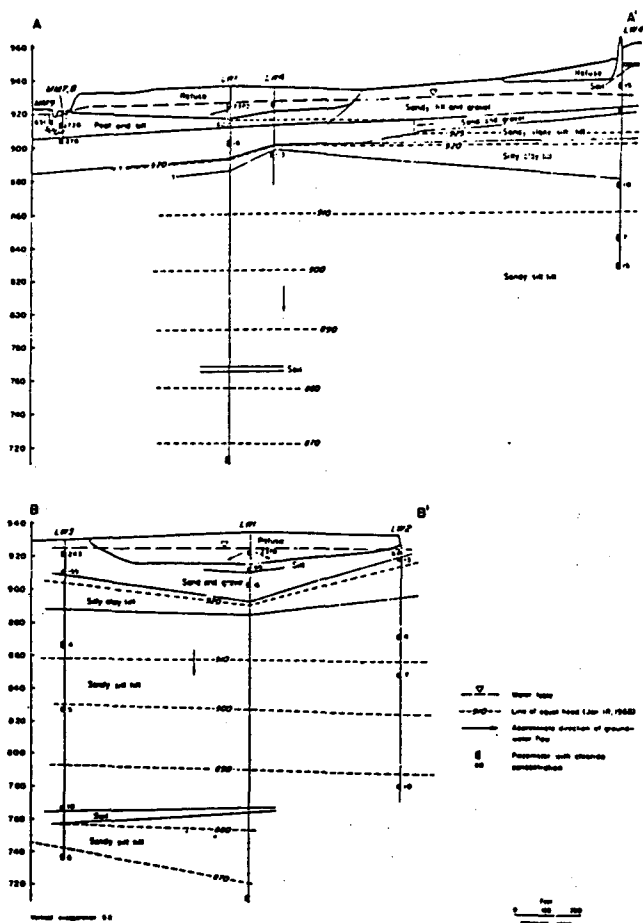


Figure 21. Cross section A-A' (top) and B-B' (bottom) of the Woodstock landfill with selected chloride concentrations. A vertical gradient in the silty clay till and a strong lateral flow of ground water in the shallow materials above the till are evident. Ground water discharges into the drainage ditch near MLL 7 and MML 8, cross section A-A'.

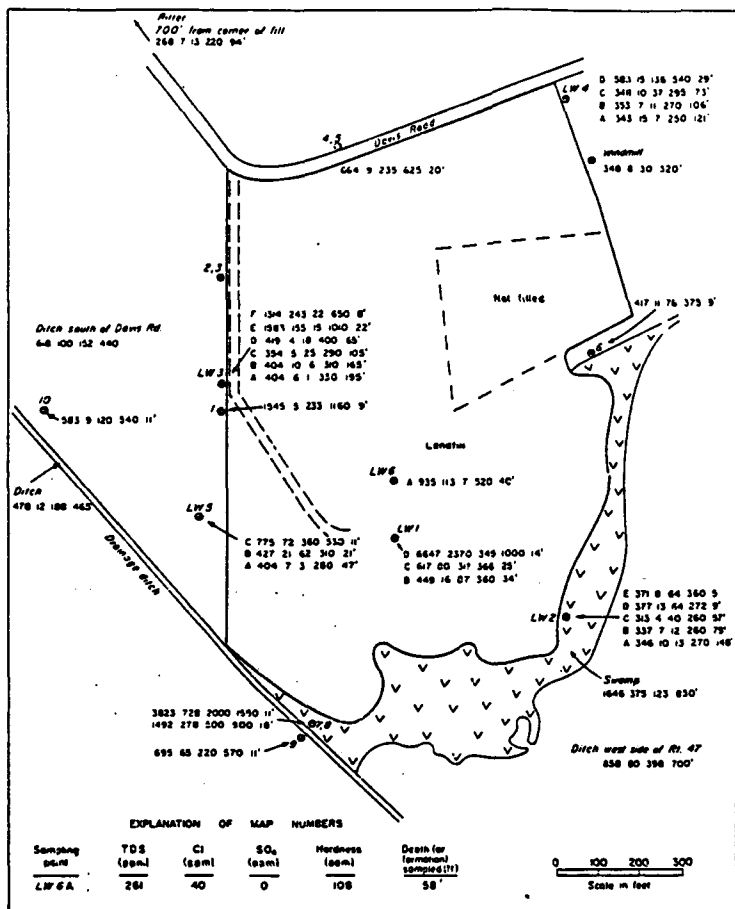


Figure 22. Water quality data for the Woodstock landfill that were gathered on November 21, 1967. The data show the expected inverse relationship between total dissolved solids and distance from the fill, with the exception of data for LW 2E, which is shallow, very close to the fill, and apparently unaffected. For unknown reasons there is no evidence of downward movement of ground water through the silty clay fill at LW 3 or LW 5.

Table 3 (Continued)
PIEZOMETER AND SAMPLING POINT DATA
WOODSTOCK LANDFILL

Well No.	Screened interval (ft.)	Sand pack interval (ft.)	Material set in	Well rating	Sealed	Comments
MM 1	7.5-8.0	0.0-8.0	Sand	1	No	
2	17.0-17.5	11.0-18.0	Gravelly sand	3	Partly	
3	6.5-7.0	0.5-7.0	Silt	3	No	
4	18.5-19.0	12.0-21.0	Gravel	1	Partly	
5	10.5-11.0	8.5-11.0	Silty sand	3	Partly	
6	6.0-6.5	0.5-6.5	Sand and gravel	1	No	Buried, 1968
7	8.5-9.0	0.5-9.0	Organic silt	2	No	
8	15.0-15.5	14.0-15.5	Organic silt	3	Partly	
9	8.5-9.0	0.5-9.0	Organic silt	2	No	
10	8.0-8.5	0.5-8.5	Organic silt	3	No	
LW 1A	220.5-223.5	209.0-223.5	Sand and gravel	4	Yes	Reduced
1B	31.0-34.0	30.0-34.0	Sand and gravel	2	Partly	
1C	22.0-25.0	-25.0	Silt	2	Partly	
1D	11.5-14.5	-14.5	Refuse	3	No	
2A	145.0-148.0	-148.0	Sand and gravel	2	Yes	Destroyed, 10/69
2B	76.0-79.0	-79.0	Sand and gravel	2	No	Destroyed, 10/69
2C	53.5-59.5	-66.5	Sand and gravel	2	No	Destroyed, 10/69
2D	8.5-9.0	-9.0	Till	2	Probably	Destroyed, 10/69
2E	4.5-5.0	-5.0	Sand and gravel	1+	No	Destroyed, 10/69
3A	182.0-185.0	180.0-185.0	Sand and gravel	2	Partly	
3B	162.0-165.0	158.0-169.0	Clay over sand and gravel	3	Partly	
3C	101.5-104.5	88.0-101.5	Sandy silt	3	Partly	
3D	62.0-65.0	55.0-65.0	Sand and gravel	1+	Partly	
3E	19.0-22.0	-22.0	Sand and gravel	1	Probably	
3F	7.0-7.5	-7.5	Sand and gravel	2	No	
4A	118.0-121.0	113.0-121.0	Sand	2	Probably	
4B	102.0-105.0	88.0-105.0	Silty sand	1+	Probably	
4C	70.0-73.0	65.0-73.0	Sand	1	Yes	
4D	26.5-29.5	-29.5	Sand and gravel	1	Yes	
4E	13.0-13.5	11.0-13.5	Sandy silty till	Dry	No	
5A	44.0-47.0	43.0-51.0	Sand	1	Yes	
5B	18.5-21.5	18.0-21.5	Sandy silt	1	Yes	
5C	9.5-10.0	8.0-10.0	Sandy silt	2	No	
6A	31.0-34.0	22.0-34.0	Sand and gravel	1+	Yes	
6B	8.0-11.0	8.0-11.0	Refuse	3	No	
7	9.75-13.75	0-13.75	Refuse	?	No	
8	13.08-17.08	0-17.08	Refuse	?	No	

WINNETKA LANDFILL (Continued)

Well No.	Depth (ft.)	Stratigraphic position	Total sample Gravel (%)	Sample Sand (%)	<2 mm diameter Silt (%)	Clay (%)	Classification
Near LW 6	1.5	Adjacent to fill	0	26	46	28	Loam
6	9.5-11	Upper till	9	19	53	28	
6	24.5-26	Upper till	3	17	49	34	
6	34.5-36	Upper till	5	10	41	49	
6	47-48.5	Lower till	1	42	45	13	
13	0.5	Cover on fill	3	40	29	23	Loam
13	1.5	Cover on fill	2	65	20	15	Sand loam
17	0.5	Cover on fill	2	40	31	29	Clay loam
17	1.5	Cover on fill	0	40	26	34	Clay loam
8	4.5-8	Surficial silt	1	21	51	22	
5	13.5-15	Upper till		bed reading			
5	26-27.5	Upper till	3	13	48	39	
5	31.5-33	Upper till	4	10	46	44	
ELGIN LANDFILL							
Near LW 7	0-1	Cover on fill	40	40	27	33	Clay loam
7	0.6	Cover on fill	15	33	36	31	Clay loam
7	1.5	Cover on fill	18	39	37	24	Loam
8	15-18.5	Surficial sand	3	10	84	6	
8	17.5-19	Surficial sand	14	95		4	
6	19.5-21	Surficial sand	65	79		21	
6	24.5-26	Upper till	13	27	41	32	
6	32-33.5	Upper till	7	33	42	25	
6	38-39.5	Basal sand	65	76		24	
WOODSTOCK LANDFILL							
Near LW 6	0.1	Cover on fill	33	53	31	16	Sandy loam
SW corner	0.1	Cover on fill	16	26	61	13	Silt loam
Near LW 2	0.1	Cover on fill	9	15	49	36	Silty clay loam
4	1.5	Topsoil adjacent to fill	1	50	34	16	Loam
NW corner	1.5	Topsoil adjacent to fill	0	94		6	Sand
Near LW 7	0.5	Cover on fill	29	48	39	13	Loam
7	1.5	Cover on fill	29	55	31	14	Sandy loam
8	0.5	Cover on fill	2	72	14	14	Sandy loam
8	1.5	Cover on fill	14	58	25	17	Sandy loam
5	24.5-26	Upper till	3	14	44	42	
5	42-43.5	Upper till	3	11	51	38	
6	35-36.5	Upper till	4	10	48	42	
5	49.5-51	Lower till	11	39	36	25	
6	39.5-41	Lower till	12	44	38	18	
6	54.5-56	Lower till	22	41	36	23	

TABLE 6 (continued)
WATER QUALITY ANALYSES BY THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH

Well No.	Date sampled	Total dissolved solids (ppm)	pH	Total COD (ppm)	Organic acids (ppm)	Hardness (as CaCO ₃) (ppm)	Sulfate (ppm)	Sodium (eq) (ppm)	Chloride (ppm)	Iron (ppm)	Manganese (ppm)	Comments
ELGIN—continued												
Farm	11-28-67	458	7.8	24	neg	240	2	100	7	10		800 ft west of site ½ mile west of LW 3
Airport	11-1-67	452	6.9	21	neg	350	18	47	4	24	0.1	
Fox River at LW1	10-24-67	404	8.3	30	neg	320	89	38	38	3	0	
Fox River at Marina	2-24-68	478	8.1	25	40				49			
Fox River at Well 1	2-24-69	481	8.0	33	50				44			
Marine	7-27-67	1,372	7.3	65	0	928	620	set 204	200		1.1	
Marine	8-30-67	1,284	7.3	20	neg	840	650	204	220	1.5	1.0	
Marine	11-1-67	1,284	7.2	23	neg	810	900	218	210	2.4	0.8	
WOODSTOCK												
LW1B	9-13-67	448	7.8	12	neg	340	68	60	22	137.67	0.4	Detergents, 2.0
1B	11-7-67	449	7.2	0	neg	360	87	41	16	12	0	
1C	9-13-67	1,003	7.8	85	75	420	28	268	150	33.6	7	
1C	11-7-67	806	7.6	19	neg	320	31	223	135	22.4	0	
1C	11-20-67	617	7.0			360		116	80			
1D	11-7-67	6,647	7.7	564	80	1,000	345	2,598	2,370	34.4	0	
1D	11-20-67	7,265	8.2			1,110		2,831	2,400			
2A	10-6-67	346	8.1	4	neg	270	13	35	10	24	0.2	
2B	10-6-67	337	8.1	2	neg	260	12	35	7	6.8	0.2	
2C	8-10-67	328	7.7	8	0	270	12	31	6	32	0	
2C	8-11-67	336	7.7	10	0	270	14.0	set 30	8	13.9	0.2	
2C	10-6-67	313	8.3	10	neg	260	40	24	4	13.8	0	

TABLE 6 (continued)
WATER QUALITY ANALYSES BY THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH

Well No.	Date sampled	Total dissolved solids (ppm)	pH	Total COD (ppm)	Organic acids (ppm)	Hardness (as CaCO ₃) (ppm)	Sulfate (ppm)	Sodium (mst) (ppm)	Chloride (ppm)	Iron (ppm)	Manganese (ppm)
WOODSTOCK--continued											
LW2D	9-13-67	377	7.4	0	neg	272	64	48	13	19.2	0.5
2E	8-10-67	371	7.4	4	0	360	64	est. 5	8	1	0
2E	11-20-67	303	7.3			333		31	15		
3A	10-8-67	404	7.9	98	neg	330	1	34	6	1.1	0
3B	10-6-67	404	8.1	0	neg	310	8	43	10	25	0.4
3C	9-13-67	352	7.8	24	neg	303	2.4	24	15	123.2	0.8
3C	10-5-67	364	7.4	12	neg	290	25	29	8	48	0.4
3D	8-10-67	452	7.8	12	20	300	14	est. 29	2	1.4	0
3D	9-13-67	480	8.1	4	neg	420	9.8	11	8	3.4	0.2
3D	10-8-67	419	7.8	14	neg	400	18	8	4	1.3	0
3D	11-20-67	472	7.4			398		25	10		
3E	9-13-67	1,533	7.5	129	neg	1,010	14.8	234	155	24.8	0
3F	9-13-67	1,235	7.4	428	75	670	22	260	195	71.2	0
3F	11-20-67	1,314	7.1			650		306	243		
4A	10-6-67	343	8.1	8	neg	250	7	43	15	48	0.2
4B	10-6-67	353	8.0	0	neg	270	11	38	7	10	0
4C	10-6-67	353	7.9	2	neg	280	46	34	8	1.8	0.3
4C	11-20-67	348	7.7	0	neg	295	37	24	10	12	0.5
4D	11-7-67	806	7.5	31	neg	430	175	150	65	4.8	0
4D	11-20-67	583	6.3	0	neg	540	133	20	15	4	0.3
5A	8-11-67	397	7.5	8	0	350	14	est. 22	4	1.2	0
5A	11-20-67	404	8.0	34	neg	280	3	57	7	20	0
5B	8-14-67	407	7.3	6	0	360	58	est. 22	19	3.1	0
5B	11-20-67	427	7.7	28	neg	310	62	54	21	3.8	0.1
5C	8-14-67	845	7.2	8	0	500	103	est. 67	80	3.7	0.4
5C	11-20-67	775	7.7	28	neg	530	360	113	72	30	1.1
6A	8-11-67	1,120	7.0	81	0	770	28	est. 165	13	5.9	0.2
6A	11-7-67	1,133	7.2	89	20	620	13	282	120	8	0
6A	11-20-67	935	7.7	68	neg	520	7	191	113	17	0

TABLE 6 (continued)
WATER QUALITY ANALYSES BY THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH

Well No.	Date sampled	Total dissolved solids (ppm)	pH	Total CO ₂ (ppm)	Organic acids (ppm)	Hardness (as CaCO ₃) (ppm)	Sulfate (ppm)	Sodium (est) (ppm)	Chloride (ppm)	Iron (ppm)	Manganese (ppm)	Comments
WOODSTOCK—concluded												
MM 1	8-14-67	1,545	6.8	59	0	1,160	253.3	est 177		12.2	0.2	
4	9-13-67	730	7.2	8	neg	720	290	5	16	24.8	0.4	
4	11-20-67	664	7.8	0	neg	625	235	18	9	17	0.3	
6	8-11-67	416	7.3	4	20	390	72	12	12	3.4	0.2	
6	11-20-67	417	8.1	0	neg	378	76	19	11	14	0	
7	11-7-67	3,823	7.4	108	neg	1,550	2000	1,046	728	33.6	0.1	
7	11-20-67	3,743	7.1			1,720		931	680			
8	11-7-67	1,492	7.2	61	neg	900	500	272	172	53	0	
8	11-20-67	1,342	7.9	4	neg	980	400	167	268	2.6	0.1	
8	2-24-69	1,236	7.2	1,103	0				238			
9	8-14-67	638	7.4	61	0	500	136	est 64	15	2.5	0	
9	11-7-67	695	7.1	61	neg	570	220	58	65	20	0.3	
9	11-20-67	718	6.9			590		59	60			
10	8-14-67	524	6.8	39	0	470	56	est 25	5	15.2	1.1	
10	11-20-67	583	7.3	31	neg	540	120	20	9	19	0.8	
10	2-24-69	563	7.0	68	0				18			
Stream near MM 10	1-18-68	478	7.0	29	50	465	188	6	12	2	0	
Stream west of LW 2	2-24-69	450	7.5	48	0				44			
Stream near MM 8 and 9	1-18-68	1,646	7.2	80	35	830	123	375	375	7	0	
Stream south side Davis Rd.	1-18-68	710	7.1	25	50	560	300	69	60	1	0	
Stream west side Rt. 47	2-24-69	595	7.5	60	20				60			
J. Fitter Vindmill	1-18-68	618	7.5	20	neg	440	152	82	100	8	0	½ mile upstream
	1-18-68	858	7.2	33	120	700	398	73	80	13	0	½ mile downstream
J. Fitter Vindmill	11-20-67	268	8.2	4	neg	220	13	22	7	0.8	0	400 feet NE of site
	9-13-67	348	7.5	0	neg	320	30	13	8	2.8	0.2	200 feet S of LW 3

MOOTGL000192

TABLE 7 (Continued)
WATER QUALITY ANALYSES BY ALLIED LABORATORIES

Well No.	Date in	Date out	pH	Iron (ppm)	Alkalinity as CaCO ₃ (ppm)	Chloride (ppm)	Sulphate (ppm)	Calcium (ppm)	Magnesium (ppm)	Total hardness as CaCO ₃ (ppm)	Sodium (by diff) (ppm)	Total Kjeldahl nitrogen (ppm)	Total nitrate-nitrite nitrogen (ppm)	Total dissolved solids by conductivity (ppm)
FP 2001	12/4/67	12/8/67	7.0	0.8	198	41	7	23	7	89	72	1.1	1.4	205
FP 2001	2/26/69		6.9	0.35	156	45	4	18	9	84				
LW 1E	2/4/67	12/8/67	6.8	17.5	3,050	1,320	25	315	93	1,170	1,640	374	1.0	4,280
1E	2/26/69		6.7	14.3	3,050	1,156	4.6	118	243	1,290	1,561			
2A	12/4/67	12/8/67	7.8	2.2	171	39	23	20	13	106	66	2.5	0.6	205
2A	2/25/69		7.5	1.2	200	42	neg	32	14	140	65			
8A	12/4/67	12/8/67	7.7	1.6	161	36	18	41	10	144	40	2.8	1.0	205
8A	12/4/67	12/8/67	7.7	1.2	178	35	20	26	7	92	72	4.3	1.2	205
8A	2/25/69		7.1	0.29	124	136	140	69	33	306	74			
9A	12/4/67	12/8/67	7.9	1.2	164	53	23	23	16	123	65			
9A	2/25/69		6.9	0.1	320	134	310	147	67	644	90		1.3	220
10A	2/26/69		7.0	0.4	342	60	20	47	20	200	114			
11	2/26/69		6.8	0.46	920	960	440	310	156	1,430	372			
Ellyn														
LW 1B	11/28/67	12/1/67	7.0	0.8	404	17	8	72	40	346	42	5.8	0.7	240
1C	11/28/67	12/1/67	7.0	1.1	515	268	131	116	76	606	194	5.5	1.0	940
3B	11/28/67	12/1/67	7.2	0.5	370	15	8	64	46	352	21	3.0	1.2	168
3B	2/25/69		6.9	0.2	342	16	10	66	40	330	21			
6A	11/28/67	12/1/67	6.9	0.5	359	15	15	71	36	328	31	2.3	1.4	220
6A	11/28/67	12/1/67	6.8	0.5	363	12	8	75	32	321	31	1.5	0.5	220
6A	2/25/69		6.7	0.28	368	23	9.5	74	39	340	32			
6B	11/28/67	12/1/67	6.8	0.6	449	126	377	134	104	766	116	1.6	0.3	630
8A	11/28/67	12/1/67	7.0	0.3	307	12	7	77	33	323	42	2.5	0.7	240
8A	2/25/69		6.8	0.55	262	67	3.4	60	41	340	49			
8B	11/28/67	12/1/67	7.1	0.5	568	182	710	167	154	1,050	243	4.5	1.0	850
8B	2/25/69		6.7	0.35	438	125	540	141	131	892	134			
Marine	2/26/69		6.8	0.85	420	158	440	118	124	808	134			
Woodstock														
MM 7	11/21/67	11/24/67	6.8	10.3	882	648	1,250	170	287	1,510	686	1.8	1.4	3,350
7	2/25/69		7.0	3.8	2,430	1,276	1,000	176	303	1,700	2,070			
9	11/21/67	11/24/67	6.7	7.2	322	70	213	142	51	568	153	3.9	0.9	580
9	2/25/69		7.0	2.59	340	57	200	141	41	520	96			
LW 1C	11/21/67	11/24/67	6.9	17	468	94	8.2	67	48	356	112	2.5	0.9	375
1C	11/21/67	11/24/67	6.9	25	434	83	8.2	62	46	346	86		1.0	445
10	11/21/67	11/24/67	7.8	6	1,410	2,320	neg	12	262	1,100	1,650	3.2	1.5	6,850
10	2/25/69		7.6	1.02	4,110	2,198	0.6	568	22	1,510	2,627			

² Dolomite well, 1/4 mile north of LW 3.

MOOTGL000194

TABLE 7(Continued)
WATER QUALITY ANALYSES BY ALLIED LABORATORIES

Well No.	Date in	Date out	pH	Iron (ppm)	M Alkalinity as CaCO ₃ (ppm)	Chloride (ppm)	Sulphate (ppm)	Calcium (ppm)	Magnesium (ppm)	Total hardness (as CaCO ₃) (ppm)	Sodium (by diff) (ppm)	Total Kjeldahl nitrogen (ppm)	Total nitrate- nitrite nitrogen (ppm)	Total dissolved solids by conductivity (as NaCl) (ppm)
2E	11/21/67	11/24/67	7.1	6.9	328	19	66	68	36	318	44	1.8	0.9	310
2E	2/26/68		7.0	1.43	340	11	66	74	40	348	30			
3D	11/21/67	11/24/67	7.1	1.4	422	12	8.2	48	66	393	26	3.0	0.7	275
3D	2/26/68		7.1	0.85	452	17	13	70	57	412	35			
3F	11/21/67	11/24/67	6.8	22	806	208	10	63	60	363	432	1.5	0.6	1060
3F	2/26/68		7.0	3.3	684	303	4.8	78	111	652	214			

TABLE 8
NEUTRON ACTIVATION ANALYSES^{1, 2}

FEBRUARY 1957					
Well No.	Bromine (ppm)	Sodium (ppm)	Chlorine (ppm)	Manganese (ppm)	Comments
Dup. LW 3C	< 0.09	7.6	2.1	0.12	Interbedded sand--not affected Interbedded sand--not affected Immediately south of fill in surficial sand Below fill in surficial sand
Dup. LW 2B	< 0.11	16	2.4	0.04	
Dup. MM 2	6.2	167	262	< 0.01	
Dup. MM 29	13.6	875	1,150	< 0.03	
DECEMBER 1957					
Well No.	Bromine (ppm)	Selenium (ppm)	Sodium bromine		Comments
DuPage LW 5B	8.2 ³	< 0.2	156		Surficial sand below fill Surficial sand immediately east of fill
DuPage MM 12	4		188		
Winnetka MM10	3.6 ³	< 0.3	95		Point within refuse
Winnetka LW 1E	11		69		Point at base of refuse
Elgin LW 5B	3.6 ³	< 0.1	115		Sand and gravel below refuse Surficial sand east of fill beside Fox River
Elgin LW 1C	1.9		115		
Woodstock LW 1D	10 ³	< 0.3	128		Point in refuse
Woodstock LW 3E	0.5		340		Surficial sand immediately west of fill

¹ Irradiated for 1 hour in Triga Reactor in January, 1957. No long-lived radioactivity detected after 2 weeks.

² Analyses performed by R. R. Ruch, Illinois State Geological Survey, Urbana, Illinois.

³ Average of duplicate runs. Estimated accuracy 25% relative value.

Well No.	pH 4.8	BOD -20 day	BOD recheck ⁵	COD	COD recheck ⁵	Total dissolved solids	TDS recheck	Pesticides ¹⁷	Alkalinity	Alkalinity ¹⁴ recheck	Alkalinity ⁴ recheck	Hardness ¹³	Chloride	Bromide ⁴	Sulfate ¹⁰	Cyanide ⁹	
DUP LW 6A		10	7			352		BDL	<u>520</u>	216	252	300	7	^	0.1	16	BDL
LW 14		230	73	284	225	372		BDL	<u>633</u>	256	247	260	17			16.4	BDL
LW 15		58		52		608		BDL	<u>750</u>	228	337	440	94	0.4	28	BDL	
LW 16		80		98		1,334	1,581	BDL	<u>1,100</u>	298	<u>1,228</u>	880	309	1.3	14	BDL	
LW 6B		225		40		1,198		BDL	<u>2,290</u>	1,040	1,011	540	136	2.8	2	0.02	
DUP LW 12A		53	13	207	34	564		BDL	<u>640</u>	264	258	350	12	^	0.1	97.5	BDL
LW 11A		290	11	36	19	448		BDL	<u>550</u>	226		280	7	^	0.1	100	BDL
LW 5B		14,080		8,000		6,794		BDL	<u>5,810</u>	4,159	2,200	1330	10	2		BDL	
						622		BDL	540	136		410	64	0.2	88	BDL	
DUP MM 4B		36		68		1,620	1,582	BDL	<u>2,130</u>	728	428	900	<u>288</u>	3.9	21	BDL	
MM 5B		180		348		1,270	7,024	BDL	5,000		<u>1,853</u>	3,180	287	5.4	BDL	BDL	
MM 4A		6,560		8,200													
						1,104		BDL	<u>1,620</u>			890	206	3	1	BDL	
DUP MM 61		125		360		5,910		BDL	<u>4,720</u>	2,646	2,250	946	12	1		BDL	
MM 63		4,560		2,940													
						2,308		BDL	<u>3,370</u>		431	1,180	429	5.8	13.8	BDL	
WIN LW 17		6,400		4,280		678	708	BDL	<u>340</u>		422	560	99	0.7	190	BDL	
LW 12		24		48		584	894	BDL	<u>1,450</u>		<u>1,424</u>	710	70	1.1	5	BDL	
LW 13		105		153		994	2,466	BDL	<u>3,630</u>		1,426	970	701	8.4	1	BDL	
LW 5B		250		415													
						1,410		BDL	790		302	1,080	102	2.3	880	BDL	
ELG LW 6B		14		30													
						530		BDL	690			470	91	0.3	24	BDL	
WOOD LW 1C		40		308													
Blackwell		54,810		39,680		19,144		BDL	11,570	3,255	7,830	1687			680	0.024	

1. Questionable values underlined.

2. Concentrations in parts per million, (ppm).

3. Sampled 1 August 1989 for pH and BOD and COD rechecks. All other samples Feb. 1989.

4. Analyzed by Teeco Hydro/Aero Sciences unless noted otherwise.

5. Analyses by the Illinois State Geological Survey.

6. Analyses by the Illinois Department of Public Health.

7. Measured within 5 minutes of sampling.

8. BDL < 0.1 milligram per liter.

9. BDL < 0.05 milligram per liter.

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TABLE 9
COMPREHENSIVE WATER QUALITY ANALYSES^{1,3}

Total phosphorus ¹⁰	Nitrate	Total nitrogen	Fluoride	As ³⁺ AS ⁵⁺	Hexane Solubles	Total magnesium	Soluble magnesium	Potassium	Potassium reduct.	Sodium	Sodium reduct.	Copper ¹²	Cadmium ¹³	Lead	Lead reduct.	Zinc	Zinc ¹⁴ reduct.	Iron total	Chromium ¹⁵
BDL	0.28	0.35		0.02	11	40	38	2		12		BDL	BDL	0.50	BDL	0.15	0.23	0.4	0.10
2.25	0.65	0.65		0.06	0	25	25	2.7		50		BDL	BDL	0.50	BDL	2.30	0.54	1.0	BDL
0.57	0.32	0.19		0.02	7	50	56	2.6		52		BDL	BDL	1.1	BDL	0.25	< 0.10	0.4	0.10
0.50	1	0.05		0.04	7	100	135	2.7		112	120	BDL	BDL	0.5	BDL	0.2	0.11	0.5	BDL
8.90	1.60	0.31		0.30	7	90	88	100		74		BDL	BDL	1	BDL	4.5	< 0.10	0.8	BDL
1.35	0.40	2.40	0.31	0.02	0	29	37	2.7		61		BDL	BDL	1	BDL	0.15	< 0.10	0.7	BDL
0.47	0.28	3.36	0.27	0.04	8	26	28	2.5		49		BDL	BDL	1	BDL	0.30	0.10	0.9	0.05
1.20	0.70	2		0.72	18	450	480	610		810		BDL	BDL	0.5	BDL	0.40	0.13	8.3	0.15
1.85	0.93	0.08		0.01	3	52	60	0.75		22		BDL							
6.50	0.17	0.15		0.08	5	163	150	58.5	50	188	198	BDL	BDL	0.5		1.70		0.3	BDL
0.24	0.65	0.39		0.152	3	175	177	264	138	238	245	BDL	BDL	1	BDL	1.40	< 0.10	1.2	0.10
												BDL	BDL	0.5	BDL	0.15	0.34	60	BDL
0.50	0.14	0.44		0.210	5	110	98	85		63		BDL							
0.17	0.50	0.29		0.260	6	725	440	220		615		BDL	BDL	1		0.10		100	0.05
												BDL	BDL	1		0.06		12	BDL
2.80	0.50	0.40		0.35	5	198	165	188		298		BDL							
0.07	0.05	0.34		0.012	3	70	50	4		110	118	BDL	BDL	1		1.50		96	0.05
1.30	0.20	0.23		0.15	8	75	67.5	38		34		BDL	BDL	0.5	BDL	1.25	< 0.10	7	0.05
2.75	0.43	0.54		0.50	4	200	171	220	200	348	358	BDL	BDL	1.0		0.10		11	0.05
												BDL	BDL	0.5		0.60		13.65	0.05
3.25	0.04	0.37		0.03	7	190	159	38		98		BDL							
												BDL	BDL	0.1		0.25		0.4	BDL
5.90	0.10	0.15		0.08	6	53	59	7		46		BDL							
												BDL	BDL	1		3.85		0.8	0.05
6	1.70				350	600		790		900		BDL						5.500	0.2
												BDL	BDL	1.3		40			

9. BDL < 0.005 milligram per liter.

10. BDL < 0.02 milligram per liter.

11. Below 0.50 ppm and probably below 0.02 ppm.

12. Not added to all samples. No glass used.

13. Blackwell value calculated from magnes concentration.

14. Back titration.

15. Methylene blue active substances (inclu

16. Indicates refuse buried.

17. BDL < 5 micrograms per liter.

Depth feet	Iron total	Chromium ⁶		Soluble calcium	Boron	Boron ^{4,12} recheck	Aluminum ⁶	Manganese ⁶	Arsenic ⁷	Selenium ⁷	Barium	Strontium ⁷	Remarks
54	0.4 0.10	BOL	75	91	1.00	0.15	0.3	BOL	6.6	BOL	0.20	BOL	Interbedded Cd. Well not drilled: samples
10	1.0 BOL	BOL	75	72	BOL	0.27	1.1	0.17	6.9	BOL	0.25	BOL	Samples 15.19 ft. below top of till
10	0.4 0.10	BOL	115	116	BOL	0.14	0.4	BOL	3.8	BOL	0.15	BOL	Samples 4.21 ft. below top of till
1.17	0.5 BOL	BOL	230	224	BOL	0.31	0.1	0.10	BOL	BOL	0.40	BOL	Samples 3.23 ft. below top of till
1.10	0.8 BOL	BOL	105	102	15.60	0.31	0.9	0.06	4.6	BOL	0.20	BOL	Screen 8 ft. below base of refum (1962) 16
10	0.7 BOL	BOL	110	66	28.40	0.27	0.7	0.07	6.	BOL	0.20	BOL	Samples 7.47 ft. below top of till
10	0.9 0.05	BOL	88	96	1.16	0.48	0.3	0.06	BOL	BOL	0.20	BOL	Samples 2.20 ft. below top of till
1.13	6.3 0.15	BOL	475	208	56.80	5.35	0.1	0.06	BOL	BOL	0.80	BOL	Screen 3 ft. below refum in sand (1963)
10	0.2 BOL	BOL	128	131	41.20	-	0.4	0.15	BOL	BOL	0.20	BOL	Samples top of surficial sand 850 ft. south
10	1.2 0.10	BOL	146	141	25.40	2.10	0.1	0.08	BOL	BOL	1.20	BOL	Samples base of surficial sand 325 ft. south
34	60 BOL	BOL	1,900	500	20.40	2.10	0.3	0.80	BOL	BOL	7.5	BOL	Samples base of surficial sand 20 ft. south
10	12 80L	BOL	440	447	25.20	-	0.2	0.08	BOL	BOL	0.3	BOL	Samples refum (1953)
10	0.05	BOL	170	155	20.	-	0.2	0.24	BOL	BOL	0.3	BOL	Samples near base of refum (1960)
10	0.05	BOL	600	100	78.40	-	0.3	1.14	BOL	BOL	0.15	BOL	Samples near base of refum (7/11/67)
10	1.7 0.05	BOL	150	109	24.60	0.60	0.4	0.10	BOL	BOL	0.15	BOL	Samples refum (1963)
10	1.1 0.05	BOL	150	109	24.60	0.60	0.4	0.10	BOL	BOL	0.15	BOL	Samples refum (1963)
10	13.06 0.06	BOL	100	108	37.20	-	BOL	0.09	BOL	BOL	0.50	BOL	Samples refum (1960)
10	0.4 BOL	BOL	220	208	-	-	0.4	0.11	BOL	BOL	0.20	BOL	Samples near base of refum (1964)
10	0.6 0.06	BOL	115	115	-	-	0.2	0.11	BOL	BOL	0.20	BOL	Samples near base of refum (1961)
10	0.6 0.06	BOL	2,150	-	300	-	2.2	1.66	4.3	2.7	8.5	BOL	Samples refum probably "squares" - south

8 calculated from magnesium and calcium

has active 3. distances (includes detrital,
ure buried
regions per liter.

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TABLE 9
COMPREHENSIVE WATER QUALITY ANALYSES^{1,2,3} - CONTINUED

Well No.	Soluble calcium	Boron	Sulfate ^{4,12} reduct	Aluminum ⁸	Manganese ⁹	Ammonia ⁷	Selenium ⁷	Barium	Barium ⁷	
DUP	LW 6A 81	1.80	0.15	0.3	BDL	8.8	BDL	0.20	BDL	Interbedded Sd. Well not polluted; samples 17.33 feet below top of till
	LW 14 72	BDL	0.27	1.1	0.17	6.8	BDL	0.25	BDL	Samples 15.19 ft. below top of till
	LW 15 116	BDL	0.14	0.4	BDL	3.8	BDL	0.15	BDL	Samples 4.31 ft. below top of till
	LW 16 224	BDL	0.31	0.1	0.10	BDL	BDL	0.40	BDL	Samples 2.57 ft. below top of till
	LW 68 102	15.60	0.91	0.9	0.08	4.8	BDL	0.33	BDL	Screen 5 ft. below base of refuse (1952) 18
DUP	LW 12A 66	28.40	0.21	0.7	0.07	8.	BDL	0.30	BDL	Samples 7.47 ft. below top of till
	LW 11A 98	1.16	0.48	0.3	0.03	BDL	BDL	0.20	BDL	Samples 2.30 ft. below top of till
	LW 58 308	96.80	8.35	0.1	0.08	BDL	BDL	0.20	BDL	Screen 3 ft. below refuse in sand (1963)
DUP	NM 29 131	41.20	-	0.4	0.15	BDL	BDL	0.20	BDL	Samples top of surficial sand 650 ft. south of fill
	NM 59 115	25.40	0.13	0.7	0.09	BDL	BDL	1.2	BDL	Samples base of surficial sand 325 ft. south of fill
	NM 44 500	20.40	2.70	0.3	0.83	BDL	BDL	7.5	BDL	Samples base of surficial sand 30 ft. south of fill (1957)
DUP	NM 61 156	20.	-	0.2	0.24	BDL	BDL	0.3	BDL	Samples refuse (1955)
	NM 63 447	35.20	-	BDL	0.00	BDL	BDL	3.5	BDL	Samples near base of refuse (1960)
WIN	LW 17 100	-	-	0.3	1.14	BDL	BDL	0.15	BDL	Samples near base of refuse (17/11/67)
	LW 12 72	26.40	0.60	BDL	0.08	BDL	BDL	0.15	BDL	Samples transition zone, 7 ft. below refuse
	LW 13 109	24.80	-	0.5	0.20	BDL	BDL	0.15	BDL	Samples refuse (1953)
	LW 58 109	37.20	-	BDL	0.09	BDL	BDL	0.50	BDL	Samples refuse (1948)
ELG	LW 68 209	-	-	0.4	0.11	BDL	BDL	0.20	BDL	Samples near base of refuse (1964)
WOOD	LW 1C 116	-	-	0.2	0.11	BDL	BDL	0.20	BDL	Samples near base of refuse (1961)
Blackwell	-	320	-	2.2	1.88	4.2	2.7	8.8	BDL	Samples refuse probably "squeezed" leachate in part

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TABLE 14
ANALYSES OF LANDFILL GASES¹

Well No.	Age of refuse	CO ₂	O ₂	N ₂	Methane	Comments	Date
OLD DUPAGE COUNTY LANDFILL							
LW 6	1952	8.1	1.2	73.7	17.0		8/7/69
LW 6	1952	8.4	10.8	84.0		Possibly a good sample	9/7/69
MM 52	1956	2.8	0.4	12.8	84.0		9/7/69
Near MM 44	1957	14.5	4.5	23.9	57.1	On landfill 50 ft north of MM 44	9/7/69
MM 75	1957	14.0	2.8	45.0	38.4		9/7/69
MM 73	1959	21.8	0.5	16.7	62.0		9/7/69
MM 30	1960	27.3	0.2	1.0	71.5		3/30/67
LW 8	1963	18.3	0.7	5.4	75.8		9/7/69
LW 5	1963	18.1	1.0	32.8	48.1		9/7/69
MM 44	1967	1.8	19.2	79.2		20 feet south of landfill	9/7/69
MM 42	1967	2.9	16.4	80.8		30 feet south of landfill	9/7/69
Near MM 42	1967	4.5	7.0	80.5		50 feet south of landfill	9/7/69
WINNETKA LANDFILL							
LW 5	1948	12.5	1.2	73.5	12.8		9/7/69
LW 13	1953	2.1	16.5	81.4		Poor sample ³	9/7/69
MM 11	1963	13.4	8.4	47.0	31.2		9/7/69
LW 17	1967	18.1	0.5	33.4	48.0		9/7/69
ELGIN LANDFILL							
LW 7	1968	5.0	4.5	90.5		Cinders, glass, and sand	9/7/69
LW 8	1964	10.4	1.1	58.4	23.1		9/7/69
WOODSTOCK LANDFILL							
LW 7	1963	3.3	15.7	81.0		Ashes and inert fill	9/7/69
LW 8	1967	15.7	1.0	58.5	24.8		9/7/69

¹ Analyses performed by W. S. Armon.

² Methane collects in abandoned boring near this point.

³ Subsequent test with "gas analyzer" showed methane present.

TABLE 15 (Continued)
PERMEABILITY VALUES OBTAINED FROM SLUG TESTS—CONTINUED

Well No.	Material met in	K permeability (cm/sec) ¹	Comments
WINNETKA SITE—continued.			
LW 8B		1.3×10^{-4}	Well completed in thin sand stringer at a depth of approximately 60 feet. Water level rose instead of dropping after slugging.
LW 9A		8.5×10^{-5}	
LW 10A			
LW 10A	← Deeper glacial till	3.4×10^{-3}	
LW 12		3.5×10^{-3}	
LW 15		2.6×10^{-3}	
LW 18		2.2×10^{-3}	
		6.4×10^{-3}	
ELGIN			
LW 4C	← Sand and gravel		Too fast—water level dropped below original level
LW 6B			
LW 8B		$> 2.7 \times 10^{-3}$	
WOODSTOCK			
MM 2		2.0×10^{-4}	Water level dropped too fast for accurate measurement
MM 3		1.7×10^{-4}	
MM 4	← Sand and gravel	2.9×10^{-4}	
LW 1C		1.1×10^{-3}	
LW 3E		$> 4.4 \times 10^{-3}$ (est)	
LW 6A		$> 2.7 \times 10^{-3}$ (est)	

¹ 1 cm/sec = 2.32×10^4 gpd/h³

TABLE 18
WOODSTOCK LANDFILL SELECTED WELLS

Well No.	Age of landfill when sampled in years ¹	Location	Comments
LW 19	6	Separated from refuse by 5 ft of silt and 10 ft of sand and gravel	Uncontaminated. Chlorides 22 ppm
LW 30	1 and 2	40 ft west of fill separated from surficial sand by 20.5 ft of silt, 12.8 ft of sand, silt, and gravel	Uncontaminated. Chlorides 17 ppm
LW 6A	4	Under landfill separated by 8 ft of peat and clayey silt	Contaminated. Chlorides 120 ppm

¹ Not reliable.

TABLE 19
INFILTRATION AND SPECIFIC YIELD DATA

Well No.	Cumulative hydrographs (ft) 10/1/68-9/30/69	Specific yield based on cumulative hydrographs (%)	Specific yield based on weekly hydrographs (%)	Total recharge (ft) 10/1/68-9/30/69	Year refuse employed	Barometric efficiency % ¹	Materials in which water level is fluctuating	Comments on hydrographs
DUP LW 7	5.58	25	1.40	1954	10-15		Badly decomposed refuse, mainly cans, plastic, earth	Hydrograph sensitive
MM 32	4.40		28 1.23	1955			Mainly silty sandy clay	Sensitive
ML 29	4.30		33 1.42	1960			Refuse—paper, glass, earth	Sensitive in 1968, some time lag in 1969
LW 13	3.03		39 1.16	1963	15-25		Refuse—mainly cans, bottle caps, etc.	Insensitive
WINN LW 58	8.45		18 1.52	1948			Cover—silty clay	Very sensitive, well located in depression
LW 13	4.16	25	1.04	1953	15-18		Refuse—glass and paper, earth?	Sensitive, some time lag in hydrograph
MM 11	3.80		34 1.29	1964			Refuse	Moderately sensitive
LW 17	3.81		48 1.74	1967	15-25		Refuse—paper, plastic relatively fresh	Recorder flooded and frozen during winter
WOOD LW 68	2.68		31 0.94	1963?			Ashes and indistinguishable fill	Moderately sensitive, located on slope
LW 7	3.91	25	0.93	1953?	5-18		Black dirt, wood, wire, cans	Sensitive
LW 8	1.53	40	0.81	1967	0		Refuse—paper, etc—relatively fresh	Insensitive
ELGIN LW 78	2.82	50	1.28	1954- 1958	10-12		Cinders, glass, sand	Not sensitive in 1968, located on slope
LW 40	5.80+		20 1.09+	1958?			Wood, glass, metal, earth	Dry 11/68—very sensitive— located on slope
LW 10	4.90		30 1.47+	1958?			Cinders, glass, cans, gravel	Dry 10 and 11/68—very sensitive—located on slope

¹ Barometric efficiency is not stable throughout year.

APPENDIX B

DESCRIPTION OF SAMPLES FROM CONTRACT BORINGS*

Old DuPage County landfill		Boring LW 4	
Boring LW 1			
	Depth (ft)		Depth (ft)
		Clayey silt cover material	0- 1½
Black, clayey silt topsoil	0- 3	Refuse—some garbage, glass, 1958 and 1964 newspapers	1½-15
Yellow-brown to black silty sand, coarse-grained grading to fine grained; black oily staining and odor	3-14	Gravelly sand, silty	15-19
Gray, silty clay till	14-24	Silty sand, very fine grained; black staining and odor; bedded at 28-29 ft.; medium to very coarse grained at 30-36 ft.	19-36
Gray, sandy silt till	24-46	Gray, silty clay till	36-41
Gray, silt till	46-64½	Sandy silt till	41-50
Yellow-brown to light gray pebbly dolomite	64½-76	Gray silt till, pebbly (poor samples at 50-80 ft.)	50-88
		Light gray dolomite	88-93
Boring LW 2			
Sand and gravel grading to silty sand at base	0-15½	Boring LW 5, 10, 11, 12, and 13	
Gray, silty clay till	15½-40	Clayey silt cover material	0- 3
Brown to black fine-grained sand	40-41½	Refuse—legible papers, wood, cans	3-15½
Gray, silty clay till	41½-45	Silty sand to sand, fine grained; bedded at 17½-19 ft.	15½-25.9
Gray silt till	45-70	Brown to gray silty clay till	25.9-33½
Light gray and pinkish gray dolomite	70-77	Arbitrary pick for base	
		Gray, sandy silt till, pebbly	33½-45
		Gray, sandy silt	45-46½
		Sand and gravel, medium to coarse grained	46½-50½
		Gray silt till (poor samples)	50½-51½
Boring LW 3			
Brown to black clayey silt topsoil, sandy at base	0- 3½	Boring LW 6, 14, 15 and 16	
Silty sand, fine grained, dirty at top and base	3½-14	Clayey silt cover material	0-3
Gray, silty clay till	14-21	Refuse and gravel—cans, bottles—little if any odor	3-12
Gray silt till, pebbly	21-40½	Silty sand, fine-grained grading to medium grained	12-16
Gray, silty clay till	40½-41½	Black sandy silt	16-23.67
Sand gravel	41½-46½	Gray, silty clay till	23.67-43
Gray silt till, pebbly at 60-65 ft	46½-65	Silty sand, medium-grained grading to very fine grained	43-48½
Yellow-brown to light gray dolomite	65-73	Gray, silty clay till (no sample)	48½-49½

*Location of borings shown as Figures 5, 10, 15, and 20.

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		Depth (ft)			Depth (ft)
Refuse—cinders, cans, wire glass and gravel		3-16	Gravel, sandy		1½-7
Brown medium-grained sand and gravel		16-22	Gray, silty clay till		7-32
Boring LW 11			Pink, sandy silt till; stringer of sand and gravel at 50-52 ft., 55-57 ft., 66-69 ft., 76-78 ft.		32-138
Cover, mainly fine — to coarse-grained sand		0-2	Sand and gravel		138-155
Refuse—wood, cloth, cans and paper—not badly decomposed		2-8	Boring LW 3		
Gravel, coarse		8-10	Black, silty clay soil		0-2
Sand, no recovery		10-15.5	Brown, sandy clay		2-3
Woodstock landfill			Sand and gravel, sandier at base		3-22
			Gray, silty clay till		22-42½
Boring LW 1			Pink, sandy silt till; medium-grained sand at 53½-54 ft.; sand and gravel at 57-64 ft.; brown clay (not till) at 64-67 ft.; sand and gravel at 67-70 ft.; very little sand in till at 70-80 ft.		42½-122
Refuse—cinders, glass, metal (poor samples)		0-19½	Gray, sandy silt till; some pink		122-130
Gray silt (poor samples)		19½-24½	Pink, sandy silt till		130-149
Sand and gravel, very coarse grained		24½-42½	Brown-gray, sandy silt till		149-161
Brown-gray, silty clay till		42½-50	Brown-gray, sandy silt till, pebbly; possibly a very silty sand and gravel (E-log would indicate former)		161-165
Pink, sandy silt till; pebbly at 67-71 ft.; wood fragments at 105-110 ft.—possibly cave; silty sand, possible stringers at 110-115 ft.		50-123	Black, silty clay soil		165-172
Gravel; some very coarse-grained sand		123-132	Brown-gray, sandy silt till		172-180
Pink, sandy silt till; pebbly at 145-150 ft., 155-160 ft.		132-160	Sand and gravel		180-185
Brown, pebbly, sandy silt, probably till; wood fragments		160-167	Brown-gray, sandy silt till		185-187½
Black, silty clay, probably soil		167-170	Sand and gravel		187½-195
Brown-gray, sandy silt till		170-180½	Boring LW 4		
Fine sand (no samples)		180½-187½	Black, silty clay soil		0-1
Brown-gray, sandy silt till		187½-203	Brown, sandy clay, gravelly		1-4
Sand, medium to coarse grained		203-207	Sand and gravel		4-7
Brown-gray, sandy silt till		207-213	Pink-brown, sandy silt till, gravelly; mostly gravel at 10-20 ft.—probably ice-contact		7-25½
Sand and gravel; some till—probably cave		213-225	Gray sand and gravel, very coarse grained		25½-29
Boring LW 2			Brown-gray, sandy silt till, gravelly		29-44
Black, silty clay soil		0-1½	Gray, silty clay till		44-68
			Gravel		68-72½
			Pink-gray, sandy silt till, gravelly; till in chunks		72½-92½

	Depth (ft)		Depth (ft)
Sand and gravel	92½-95½	Gray, silty clay till	34½-37½
Pink, sandy, silty till	95½-100	Pinkish gray, sandy silt till; pink at 36½-37½ ft.	37½-58
Silty sand, medium grain; 1; some gravel	100-106		
Pink, sandy, silty till; sand at 116½-118 ft.	106-121	Boring LW 7	
Boring LW 5		Loam to sandy loam cover material—contains glass and cinders	0-2
Black silt soil	0-4	Sand and coarse gravel, cinders, glass, and plastic	2-4
Brown to gray sandy silt, very finely grained	4-23	Black dirt, wood, wire, cans	4-12?
Gray, silty clay till	23-44	Gray organic silt	12?-16
Sand, fine to coarse grained	44-45½		
Pinkish gray, sandy silt till	45½-51		
Boring LW 6		Boring LW 8	
Cover, refuse—ashes, wood, and indistinguishable fill	0-15	Cover material—sandy loam	0-2
Peat and clayey silt, spongy	15-23	Refuse—paper, glass, etc not badly decomposed	2-13
Sand and gravel, coarse grained grading to fine grained	23-34½	Drilled like gravel—no returns	13-18

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10^{-2} ft/ft and a specific yield of 0.10

$$\frac{5 \text{ gpd/ft}^2 \times 3.5 \times 10^{-2} \text{ ft/ft} \times 365}{7.48 \times 0.10} = 85.2 \text{ ft/yr}$$

ELGIN LANDFILL

1.45 x 10⁶ ft² Surface area (A) of fill*
1.25 ft/yr Estimated yearly infiltration based on table 19

Total infiltration = 1.45 x 10⁶ ft² x 1.25 ft/yr = 1.81 x 10⁶ ft³/yr = 6.6 x 10⁴ gpd

Dilution in Fox River

Low flow 7.76 x 10⁴ gpd + 6.6 x 10⁴ gpd = 120†

Average flow 4.89 x 10⁴ gpd + 6.6 x 10⁴ gpd = 7,400†

This estimate assumes that all the water infiltrating into this landfill moves to the river.

Since this is a discharge zone, there is no downward movement. The estimate maximizes the possible level of pollution entering the river by making no allowance for dilution by ground water infiltrating between the landfill and the river.

WOODSTOCK LANDFILL

1.1 x 10⁵ ft² Surface area (A) of fill
1 ft/yr Estimated yearly infiltration based on table 19

Total infiltration = 1.1 x 10⁵ ft² x 1 ft/yr = 1.1 x 10⁵ ft³/yr = 22,500 gpd (2.2 x 10⁴)

Estimated flow in the drainage ditch is 10⁴ gpd and on the assumption that gpd reaches this ditch, it would allow dilution of (1 x 10⁴ gpd + 2.35 x 10⁴ gpd) = 45 times. This does not take into account water moving downward inside or outside of the fill boundaries or dilution and attenuation of leachate between the fill and the drainage ditch.

*A maximum figure, since it includes old ash, which appears to have nearly stabilized, and relatively thin fill.

†Stream flow data from Water Resources Data for Illinois, 1966 (U.S. Dept. of the Interior, Geological Survey, Water Resources Division, 1967), Part 1, p. 111.